TF 995B/5

TF 995B/5

F.M./A.M. Signal Generator

INSTRUCTION MANUAL

MP MASTER
MA23719

MARCONI INSTRUMENTS

Alternative Colour Coding
for Mains Leads
(Red - Black - Green series)

WARNING

The colour coding on mains leads is being changed to conform with international recommendations. During the change-over period, the instrument with which this manual is issued may be wired in either the old or new colours as follows:

	Old colour code	New colour code	Sleeve symbol
LINE (PHASE)	Red	Brown	
NEUTRAL	Black	Blue	N
EARTH (GROUND)	Green	Green/Yellow	⏚

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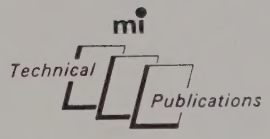
Instruction Manual
No. EB 995B/5
for

F.M./A.M. Signal Generator
TF 995B/5



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Section
I

General information

1.1 INTRODUCTION

The Marconi F.M./A.M. Signal Generator TF 995B/5 covers the frequency range of 0·2 to 220 MHz in five bands. Its output can be unmodulated, frequency modulated, or amplitude modulated; if required, both frequency and amplitude modulation can be applied simultaneously. The modulation frequency is obtained from either an internal 3-frequency oscillator, or an external source.

The open-circuit output voltage is variable by means of resistive step attenuators from 1 μV to 100 mV at 52 ohms and 1 μV to 200 mV at 75 ohms. A plug-in 20-dB Attenuator Pad, available as an optional accessory, extends the range down to a nominal 0·1 μV at both impedances.

The high-discrimination tuning required for testing narrow-band systems is facilitated by the inclusion of a fine tuning control. In addition, small known changes in carrier frequency can be made by means of two incremental-frequency controls; one of these controls gives a stepped adjustment while the other allows continuous interpolation between steps. On the two highest bands, the stepped control provides shifts of 20 and 40 kHz in either direction and the calibration marks on the continuous control are only 1 kHz apart; on the lower bands, the total shift is determined by a simple division of the reading on both dials.

A high degree of frequency stability has been achieved by use of temperature-compensating components; after warm-up, drift is less than 400 Hz per minute at a carrier frequency of 200 MHz.

The inclusion of a Carrier on/off switch makes it possible for the Generator output to be temporarily interrupted without affecting the output impedance; this facilitates a number of two-signal receiver tests such as intermodulation and blocking which involves the simultaneous use of two signal generators. Spurious f.m. due to hum is less than 25 Hz deviation, and the low level of noise modulation makes the TF 995B/5 fully suitable for applications such as adjacent-channel testing on receiver systems using a channel separation of 25 kHz or less.

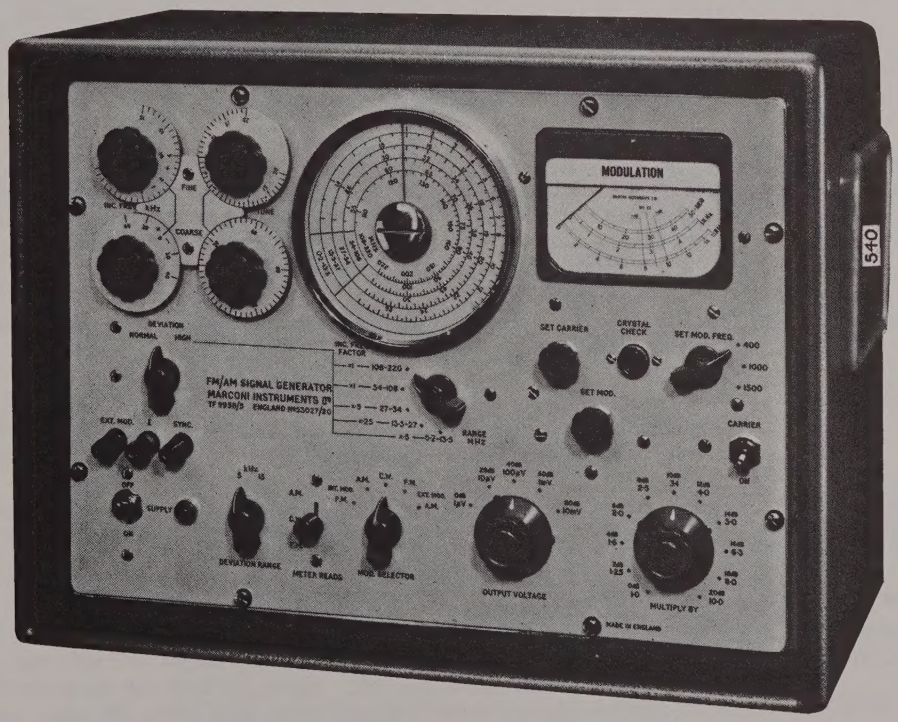


Fig. 1.1 F.M./A.M. Signal Generator TF 995B/5

1.2 DATA SUMMARY

Frequency

RANGE: 0·2 to 220 MHz in five bands as follows:

Band 1	...	...	0·2 to 13·5 MHz
2	...	...	13·5 to 27·5 MHz
3	...	...	27 to 55 MHz
4	...	...	54 to 110 MHz
5	...	...	108 to 220 MHz

CALIBRATION ACCURACY: From 0·2 to 13·5 MHz, the main frequency dial calibration has an average accuracy of ± 3%. From 13·5 to 220 MHz, the calibration of this dial is accurate to within ± 1%. In addition, the built-in crystal calibrator provides 14 check points to an accuracy of 2 parts in 10^4 on each of the four higher-frequency bands.

STABILITY: After warm-up, drift is not greater than 0·002% in a 10-minute period. Band 1: After a 45-minute warm-up, the frequency drift is not greater than ± 3 kHz or ± 0·1% whichever is the greater in a 15-minute period.

FINE TUNING CONTROL: The fine tuning control provided is arbitrarily calibrated −20 to + 20. It has a total cover of approximately 6 kHz on bands 1 and 3, 3 kHz on band 2, 12 kHz on band 4, and 24 kHz on band 5.

INCREMENTAL CONTROL: Two controls are provided, one stepped, the other continuously variable. The stepped control enables the carrier frequency to be shifted by ± 20 and ±10 kHz on band 3, ±10 and ± 5 kHz on band 2, and ± 40 and ±20 kHz on bands 4 and 5, ± 20 and 10 kHz on band 1 above 220 kHz. Below 220 kHz, the increment frequency should be such that the instantaneous frequency never goes below 220 kHz. The continuous control has a cover of ± 0·75 of one increment of the stepped control on any band, e.g. cover is ±15 kHz on bands 4 and 5.

Output

VOLTAGE: Built-in coarse and fine 75-ohm attenuators connected in cascade provide—in conjunction with the 6-dB Terminating Unit—a source e.m.f. variable in 2-dB steps from 1 μV to 100 mV. Interpolation between the 2-dB steps is by means of a ± 1-dB calibration on the r.f. level meter.

HIGH OUTPUTS: Source e.m.f.'s up to 200 mV at an impedance of 75 ohms are obtained direct from the Generator output cable.

LOW OUTPUTS: Source e.m.f.'s down to a nominal 0·1 μV at impedances of 75 and 52 ohms are obtained by inserting the 20-dB Attenuator Pad TM 5552 between the Generator output cable and the Terminating Unit.

ACCURACY: The accuracy of the joint indication of the attenuators and level meter is within ± 1 dB ± 0·25 μV up to 100 MHz, and within ± 2 dB ± 0·25 μV up to 220 MHz.

Modulation

FREQUENCY MODULATION: Normal deviation continuously variable in two ranges ± 5 kHz and ± 15 kHz on all carrier bands above 215 kHz. Below 215 kHz the deviations should be such that the instantaneous frequency never goes below 200 kHz. Accuracy at maximum deviation on bands 2, 3, 4, 5* at 1 kHz is ± 5% of f.s.d. with a

possible additional variation of ±10% due to valve ageing or random replacement.

High deviation is also available:—

×2 normal on band 1 above 230 kHz. Below 230 kHz, the deviation should be such that the instantaneous frequency never goes below 200 kHz.
×2 normal on band 3, ×4 normal on band 4, and ×8 normal on band 5. Internal modulation is available at frequencies of 400 Hz, 1000 Hz and 1500 Hz with modulation distortion not exceeding 2% at maximum deviation. The external modulation characteristic is flat, within 1 dB, from 50 Hz to 15 kHz with respect to 1 kHz.

SPURIOUS F.M. ON C.W.: The spurious f.m. due to hum does not exceed 25 Hz deviation on bands 2, 3, 4, 5*. The unusually low level of spurious noise modulation allows full use of the Generator for adjacent-channel testing on receivers designed for systems employing channel separations as small as 22·5 kHz.

*The wide frequency coverage on band 1 (0·2 to 13·5 MHz) is achieved by heterodyning the normal band 2 signal with a fixed oscillator. At some frequencies on band 1, spurious F.M. in excess of the figure quoted for the other bands may occur. At these frequencies the deviation accuracy will also be affected.

AMPLITUDE MODULATION: Available internally at 400 Hz, 1000 Hz and 1500 Hz to a depth variable up to 50% with distortion not exceeding 6% at 30% depth. External frequency characteristic (with input adjusted for constant modulation-meter reading) is flat within 0·5 dB from 100 Hz to 10 kHz.

A.M. DEPTH INDICATION: Indication accurate to within 5% modulation.

SYNCHRONIZING SIGNAL: Available from front-panel terminals at 400 Hz, 1 kHz or 1·5 kHz.

Power Supply: 200 to 250 volts, or 100 to 150 volts after adjusting internal link, 40 to 65 Hz; 65 watts. Models supplied ready for immediate 100- to 150-volt use if specified at the time of ordering.

Dimensions and Weight:

Height	*Width*	*Depth*	*Weight*
330 mm (13 in)	445 mm (17½ in)	220 mm (8½ in)	18·1 kg (40 lb)

1.3 ACCESSORIES

Supplied

One Terminating Unit Type TM 5551; 75 ohms in, 52 and 75 ohms out.
Two Coaxial Free Plugs, Type BNC; one 50-ohm, one 75-ohm; for Terminating Unit outlets.
One Telephone Plug, Igranic Type P40; for Crystal Check jack.
One Instruction Manual No. EB 995B/5.

Available

20-dB Attenuator Pad Type TM 5552; for use between output cable and Terminating Unit.

Section
2

Operation

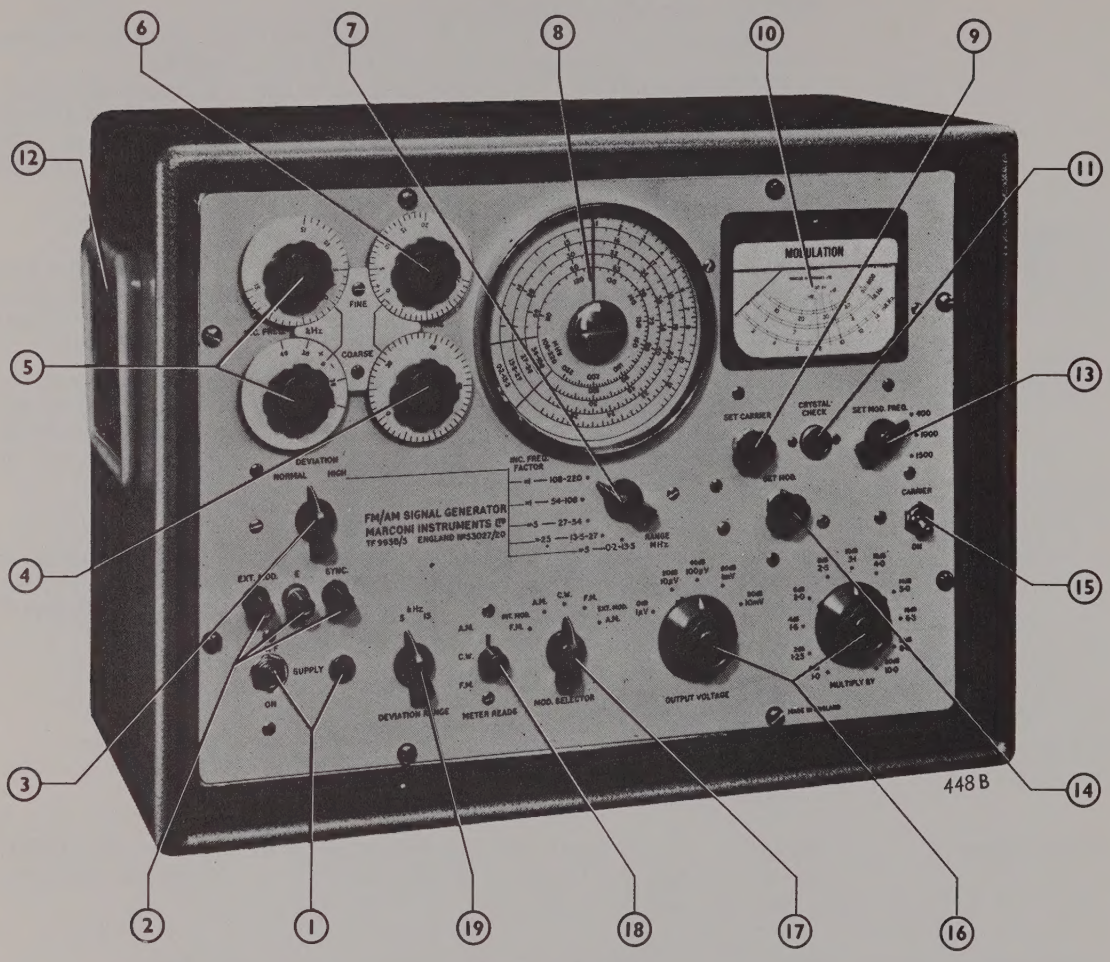


Fig. 2.1 Controls

1. **Pilot Lamp** and **Mains Supply Switch**
2. **External Modulation Input** for f.m. or a.m. and **Sync Output** from internal modulation oscillator
3. **Normal:** deviation is as shown on meter
   High: multiply meter reading by factor on Range switch
4. **Coarse Tuning Control**
5. **Incremental Frequency Controls**
   Carrier shift is given by dial readings multiplied by factor on Range switch
6. **Fine Tuning Control**
7. **Range Selector**
8. **Main Tuning Dial**
   Knurled boss adjusts cursor to standardize scale against crystal check points
9. **Set Carrier Control**
   For adjusting unmodulated carrier to Set R.F. mark on meter
10. **Meter** indicates carrier level, f.m. deviation, or a.m. depth depending on setting of Meter Reads switch
11. **Crystal Check Jack**
    Plug in headphones here to switch on crystal check oscillator
12. **Case Handle Recess** stowage for mains supply plug
13. **Modulation Frequency Selector**
    Choice of 3 frequencies from internal oscillator
14. **Set Mod Control**
    Adjusts f.m. deviation or a.m. depth
15. **Interrupts Output** without switching off filaments
16. **Output Attenuators**
    Direct reading in source e.m.f. at output of Terminating Unit when carrier is adjusted to Set R.F. mark on meter
17. **Modulation Selector**
18. **Meter Function Selector**
19. **Deviation Range Selector**
    Read deviation from corresponding scale on meter

2.1 INSTALLATION

Unless otherwise specified, the Signal Generator is dispatched with its valves in position and with its mains input circuit adjusted for immediate use with a 240-volt, 40- to 65- Hz mains supply. The instrument can be adjusted for operation from any other 40- to 65-Hz supply voltage in the ranges 200 to 250 and 100 to 150 volts. To check or alter the settings of the mains transformer tappings, refer to MAINTENANCE, Section 5.3.

2.2 SWITCHING ON AND WARMING UP

Before switching on, be quite sure that the instrument is correctly adjusted to suit the particular mains supply to which it is to be connected. Then proceed as follows:—

(1) Connect the mains lead—stowed in the left-hand case-handle recess—to the mains supply socket.

(2) Switch ON by means of the SUPPLY switch; the red pilot lamp should now glow.

(3) Before proceeding further, allow a short time —say five minutes—to elapse for the internal circuits to warm up. If a particularly high standard of frequency stability is required, this time should be increased to about 60 minutes.

2.3 OUTPUT CONNECTIONS

The r.f. output from the Signal Generator is derived, at a source impedance of 75 ohms, via a permanently attached coaxial lead fitted with a BNC free socket; the lead is stowed in the right-hand case-handle recess.

The TERMINATING UNIT, which will normally be plugged on to the output lead, has two outlets, one of 75 ohms impedance and the other of 52 ohms. Two free plugs are supplied for making connection to the TERMINATING UNIT outlets.

The 20-dB ATTENUATOR PAD, available as an optional accessory, can be inserted between the Generator output socket and the TERMINATING UNIT input plug when low outputs are required.

Details on the use of the TERMINATING UNIT and ATTENUATOR PAD are given in Section 2.6, R.F. OUTPUT ARRANGEMENTS.

Equivalents to the free plugs supplied, and illustrated in Fig. 2.3, are as follows:—

	75 ohm	*50 ohm*
Great Britain,		
Air Ministry:	10H/20946	10H/20935
Films and Equipment:	UG-260/U	UG-88/U
Transradio Ltd.:	BN. 1/7	BN. 1/5
Belling and Lee:		L. 1331/FP
United States,		
Military No.:	UG-260/U	UG-88/U

2.4 TUNING

The various aspects of tuning the Generator are dealt with in the following sections.

2.4.1. General tuning.
2.4.2. Standardizing frequency against crystal oscillator.
2.4.3. Use of incremental frequency controls.
2.4.4. Interpolation of main frequency scales.

2.4.1 GENERAL TUNING

The TF 995B/5 covers the range 0·2 to 220 MHz in five bands as follows:

Band 1	0·2 to 13·5 MHz
2	13·5 to 27·5 MHz
3	27 to 55 MHz
4	54 to 110 MHz
5	108 to 220 MHz

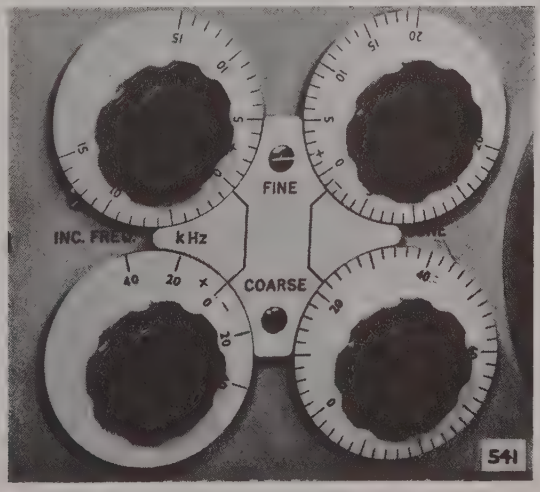


Fig. 2.2
Details of tuning arrangements

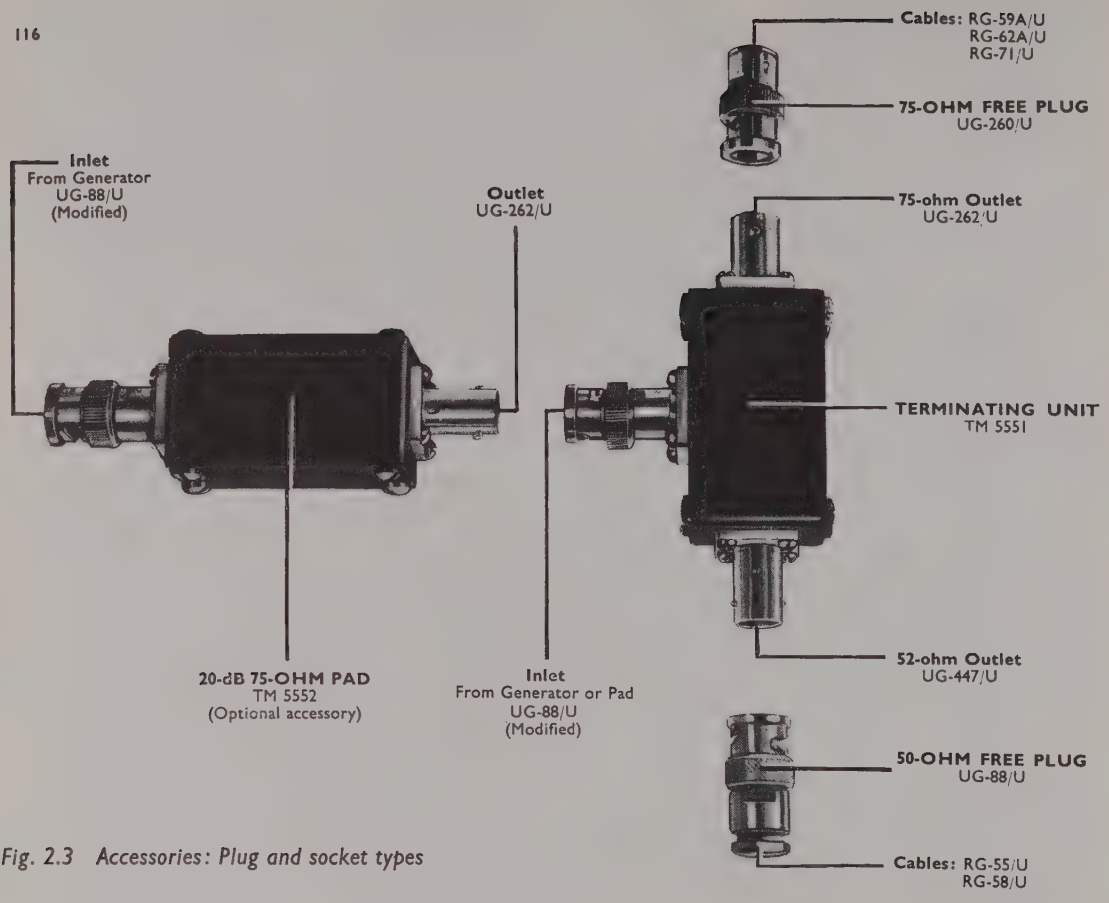


Fig. 2.3 Accessories: Plug and socket types

The particular band required is selected by means of the RANGE switch. Rotation of the COARSE TUNE control varies the output frequency within the limits of the band selected, and moves the main dial relative to its cursor.

The FINE TUNE control has a very small coverage and is incorporated to assist in the precise tuning required in tests involving narrow-band equipment. The total coverage of this control on each band is as follows:

Band 1	...	...	6 kHz
2	...	...	3 kHz
3	...	...	6 kHz
4	...	...	12 kHz
5	...	...	24 kHz

The Signal Generator has a built-in crystal calibrator, and the cursor of the main tuning dial is mounted so that its angular position relative to that of the dial is variable over a small arc by movement of a milled boss at the centre of the dial. This movable cursor enables the operator to standardize the frequency scale of the Signal Generator at any time; the cursor is used in conjunction with the crystal calibrator in the manner described in Section 2.4.2.

In addition to the RANGE switch and the TUNE controls, the instrument is fitted with calibrated incremental-frequency controls; the method of using these controls is described fully in Section 2.4.3. Section 2.4.4 deals with the method of interpolating between main dial markings by means of the linearly calibrated dial on the COARSE TUNE control.

2.4.2 USE OF THE CRYSTAL CALIBRATOR

(a) Description

Accurate calibration of the main tuning dial may be effected with the built-in crystal oscillator. This oscillator has a fundamental frequency of 333·3 kHz with an accuracy of 2 parts in 10^4 and is coupled to the basic 4·5- to 9·16-MHz r.f. oscillator which drives the multiplier chain. The calibrator circuit

is automatically brought into use when a pair of high-resistance headphones are plugged into the CRYSTAL CHECK jack socket; with the aid of the headphones, the difference frequency between the basic oscillator and the harmonic multiples of the calibrator's 333·3 kHz can be monitored aurally.

Because the outputs on the four higher-frequency bands are all derived directly from the multiplier chain, their frequencies have an exact integral relationship to the frequency of the basic oscillator. It follows, therefore, that setting the COARSE TUNE control to bring the basic-oscillator frequency to that of a crystal harmonic will also bring the frequency of the outputs from the multiplier chain to a known relationship with the crystal harmonic, and allow the frequency dial to be standardized with a high degree of accuracy.

Outputs on the lowest-frequency band are not derived directly from the multiplier chain; their generation involves a heterodyne action between the 27- to 55-MHz multiplier and a 30-MHz fixed oscillator which is not locked to the basic oscillator. For this reason, although use is made of the crystal calibrator when setting up for 0·2- to 13·5-MHz outputs, the accuracy of standardization is of a lower order than that obtained on the four higher-frequency bands.

(b) Check-Point Frequencies

The calibrator provides a total of 56 check points between 13·5 and 220 MHz; these occur as follows:

Band 2, 13·5 to 27·5 MHz: at all multiples of 1 MHz from 14 to 27 MHz inclusive.

Band 3, 27 to 55 MHz: at all multiples of 2 MHz from 28 to 54 MHz inclusive.

Band 4, 54 to 110 MHz: at all multiples of 4 MHz from 56 to 108 MHz inclusive.

Band 5, 108 to 220 MHz: at all multiples of 8 MHz from 112 to 216 MHz inclusive.

(c) Standardization Procedure

As shown above, the calibrator allows the frequency scale to be checked at 14 different points on each of the above bands, and the adjustable cursor can be set to correspond exactly with any one of these points.

When the Signal Generator is to be used above 13·5 MHz to provide an output at a single spot frequency, or over a narrow band of frequencies, the cursor should be set up at the nearest crystal check point.

When the Signal Generator is to be used over a wide range of frequencies, and it is inconvenient to reset the cursor for each material frequency change, or, alternatively, when using the 0·2 to 13·5-MHz band, the procedure is varied to reduce the mean error to a minimum. The method of standardizing the frequency scale for subsequent general use is as follows:—

(1) Set the INC. FREQ. controls to zero and the FINE TUNE control to mid-position.

(2) Set the RANGE switch to 13·5–27 MHz.

(3) Using the headphones plugged into the CRYSTAL CHECK jack, tune the main dial to a crystal check point near the centre of the band; e.g. 20 MHz.

When using the calibrator, the MOD. SELECTOR must be set to a position other than INT. MOD.—F.M. or EXT. MOD.—F.M. This ensures that the variable oscillator is not being frequency modulated —a condition which prevents precise setting of the COARSE TUNE control for the lowest-frequency beat note in the headphones, since it gives rise to a fluctuating tone.

After using the calibrator, the Signal Generator can, of course, be set up for f.m. without invalidating this frequency standardization.

(4) Adjust the milled boss in the centre of the dial to bring the cursor exactly in line with the calibration mark corresponding to the crystal check point.

If the Signal Generator has been out of use for some time, it may be necessary to use a coin in the slot provided in order to rotate the milled boss.

(5) Check the calibration accuracy at several crystal check points both above and below the check point at which the cursor was set in (4) above.

(6) Readjust the cursor setting to equalize the errors over the band; e.g. it might be found that, with the frequency scale indication correct at 20 MHz, the indication was high at both 15 and 25 MHz—in such a case, the errors would be equalized by making the indication a little low at 20 MHz, and thus not so high at 15 and 25 MHz.

It will be noted that, in the above procedure, the frequency scale is standardized on the 13·5- to 27-MHz band. This band is specified since its corresponding scale calibrations occupy the longest arc on the dial. The dial can therefore be read with a high degree of discrimination on this band and the correct cursor setting most easily determined. Once the frequency scale has been standardized on the 13·5- to 27-MHz band, the cursor is correctly set to give the minimum mean error on the other three direct-multiple bands. It is also correctly set for the 0·2- to 13·5-MHz band.

When standardized in this way, the main tuning dial indication for frequencies above 13·5 MHz is accurate to at least 1%, and will generally be within ± 0·5%; for frequencies below 13·5 MHz, the average error does not exceed ± 3%.

2.4.3 INCREMENTAL FREQUENCY CONTROLS

These controls are well suited to performing bandwidth or similar measurements since they are a convenient means of producing small, accurately-known changes in carrier frequency. They are not connected directly to the r.f. oscillator either mechanically or electrically, but operate by varying the d.c. potential at the grid of the reactor valve so that they are completely free from backlash of any kind.

To utilize these controls, proceed as follows:—

(1) With the INC. FREQ. controls set to their centre-zero position, tune the Signal Generator to the required centre-frequency by means of the RANGE switch and the TUNE controls.

(2) Rotate the INC. FREQ. controls to produce the required shift or the required change in response depending on the method of measurement.

The scales of the INC. FREQ. dials are direct-reading on bands 4 and 5. For each of the other bands, a multiplying factor must be applied, the appropriate factor for each frequency band is engraved on the front panel adjacent to the RANGE switch marking. The multiplying factors are also given below in Table 1.

2.4.4 THE INTERPOLATING DIAL

The COARSE TUNE dial is calibrated linearly from 0 to 100 and makes approximately 17 revolutions as the main dial is tuned through a complete band.

This dial may be used to subdivide linearly any part of the frequency scale in order to tune accurately to a frequency which lies between two crystal check points. To do this, proceed as follows:—

(1) Set the INC. FREQ. controls to zero.

(2) Set the RANGE switch to whichever of the four higher-frequency bands includes the required frequency.

(3) Tune the Signal Generator to the nearest crystal check point *below* the required frequency—as indicated on the main tuning dial—identifying the point with the aid of headphones plugged into the CRYSTAL CHECK jack, and noting the interpolating dial reading for the lowest-frequency beat note.

(4) Tune the Signal Generator to the nearest crystal check point *above* the required frequency and note the change of reading of the interpolating dial. It is important that the *total* change is noted when the dial is turned through more than one revolution.

The relationship should be determined between the crystal check points which embrace the particular section of the frequency band over which incremental variations are to be made. Also, the relationship should be redetermined for each different section of the frequency band, since it varies, not only from band to band, but also for different sections of any one band.

(5) From the difference in frequency between the two crystal check points, and the total number of interpolating dial divisions traversed, calculate the frequency change per interpolating dial division; this change may be conveniently expressed in kHz per division.

(6) With the aid of the headphones, reset the main tuning dial to the crystal check point below the required frequency.

TABLE I

RANGE switch setting (MHz)	*Total coverage of INC. FREQ. controls (kHz)*	*Multiply INC. FREQ. dial readings by*	*Incremental Frequency change per division (kHz per div)*	
			COARSE	*FINE*
0·2–13·5 (Band 1)	± 27·5	0·5	10	0·5
13·5–27·5 (Band 2)	± 13·75	0·25	5	0·25
27–55 (Band 3)	± 27·5	0·5	10	0·5
54–110 (Band 4)	± 55	1	20	1
108–220 (Band 5)	± 55	1	20	1

(7) Rotate the COARSE TUNE control so that the interpolating dial traverses the correct number of divisions to give the required frequency.

It is recommended that the required frequency should always be approached from the low-frequency side in order to eliminate all possibility of error due to backlash.

The following example illustrates the use of the interpolating dial to obtain an output from the instrument at an accurate frequency of 74·25 MHz.

Example: With the TUNE control set to the crystal check point at 72 MHz, the interpolating dial reading was 17. With the TUNE control set to the crystal check point of 76 MHz the new reading on the auxiliary dial was 40. The total number of interpolating dial divisions traversed was 123, the dial having rotated through slightly more than one revolution for the frequency change of 4 MHz, i.e. 4,000 kHz. In this case, a change of 1 division on the interpolating dial corresponded, *between* 72 *and* 76 *MHz*, to a nominal frequency change of

$$\frac{4{,}000}{123} = 32{\cdot}5 \text{ kHz}.$$

Therefore, by starting from the original auxiliary dial setting at 72 MHz (72,000 kHz) the required frequency of 74·25 MHz (74,250 kHz) was obtained by rotating the auxiliary dial through

$$\frac{74{,}250-72{,}000}{32{\cdot}5} = \frac{2{,}250}{32{\cdot}5} = 69 \text{ divisions}.$$

Since it will be appreciated that only typical figures could be quoted above, it follows that the relationship between frequency change and change in interpolating dial setting should be determined —in the manner outlined above—for the particular TF 995B/5 in use.

2.5 SETTING UP FOR C.W. OR MODULATED OUTPUT

The Signal Generator will give the following types of r.f. output:—

(1) Continuous wave (see Section 2.5.1).

(2) Amplitude modulated (see Section 2.5.2), variable to 50% depth,
   (a) from the internal a.f. oscillator at 400, 1,000, or 1,500 Hz,
   (b) from an external sinewave source, within the range 100 Hz to 10 kHz.

(3) Frequency modulated (see Section 2.5.3), variable to maximum frequency deviations ranging from 15 kHz to 120 kHz,
   (a) from the internal a.f. oscillator at 400, 1,000, or 1,500 Hz,
   (b) from an external sinewave source, within the range 50 Hz to 15 kHz.

(4) Simultaneous frequency and amplitude modulation (see Section 2.5.4); the amplitude modulation being obtained from the internal a.f. oscillator, and the frequency modulation from an external source as (3) (b), above.

When setting up for amplitude or frequency modulation as described in Sections 2.5.2 and 2.5.3, it may be observed that, with the METER READS key held to either A.M. or F.M. as applies, the apparent modulation as measured on external apparatus is

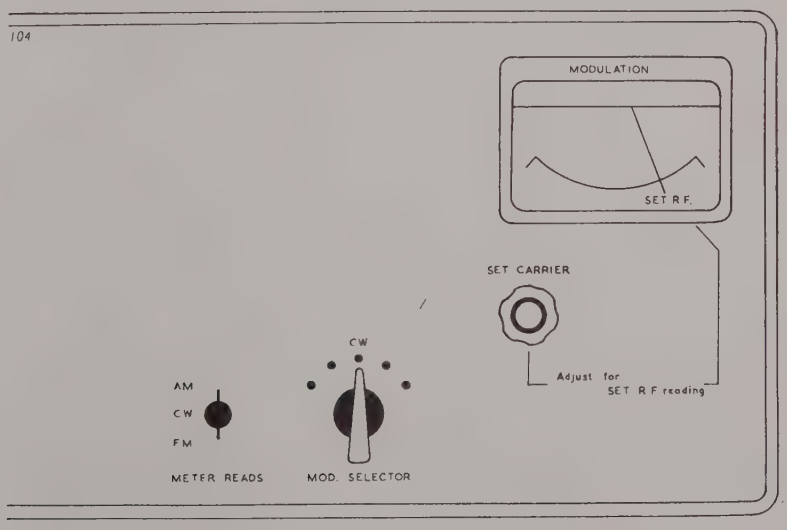


Fig. 2.4 C.W. operation

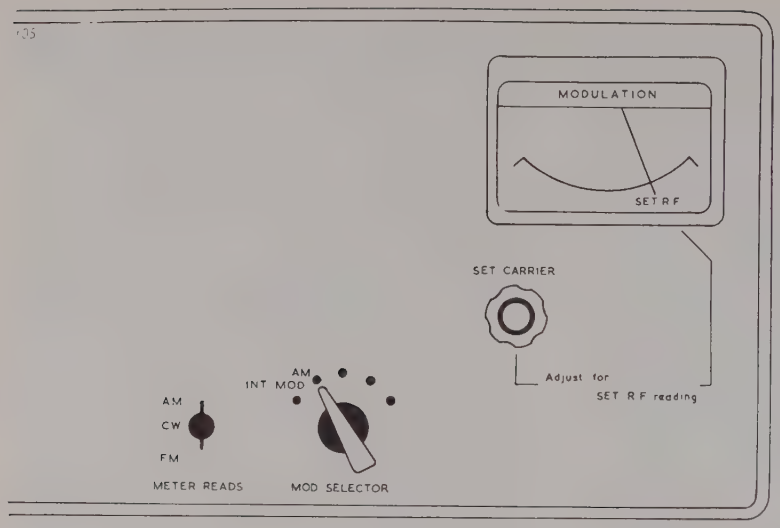


Fig. 2.5 (a)
Internal a.m. operation
(i) Setting carrier level

less than that indicated on the meter. This is quite in order; the meter indicates the modulation which will be obtained when the switch is returned to its central position and the meter reverts to its normal function of monitoring the r.f. level.

2.5.1 CONTINUOUS WAVE

(1) Set the MOD. SELECTOR switch to C.W.
(2) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.

2.5.2 AMPLITUDE MODULATION

(a) From the internal 3-frequency oscillator

(1) Set the MOD. SELECTOR switch to INT. MOD.—A.M.
(2) Turn the SET MOD. FREQ. switch to give the required modulation frequency—400, 1,000, or 1,500 Hz.
(3) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.
(4) With the METER READS key switch held in the A.M. position, adjust the SET MOD. control to the required modulation depth, as indicated on the top scale of the panel meter. Amplitude modulation is variable to a maximum depth of 50%.
(5) Release the METER READS key switch and, if necessary, repeat (3) above.

(b) From an external a.f. source

(1) Set the MOD. SELECTOR switch to EXT. MOD.—A.M

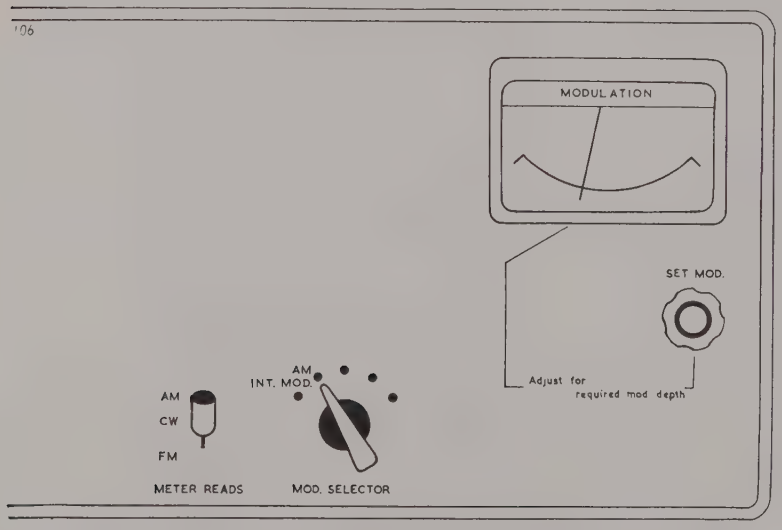


Fig. 2.5 (b)
Internal a.m. operation
(ii) Setting modulation depth

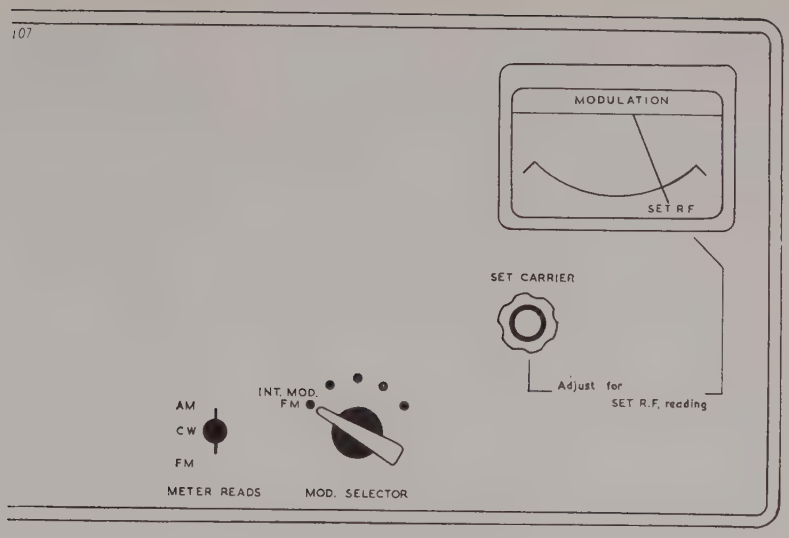


Fig. 2.6 (a)
Internal f.m. operation
(i) Setting carrier level

(2) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.
(3) Connect the external modulation source to the EXT. MOD. and E terminals.
(4) With the METER READS key switch held in the A.M. position, adjust the SET MOD. control to the required modulation depth, as indicated on the top scale of the panel meter. With the SET MOD. control at maximum, an input of approximately 15 volts r.m.s. is required at the EXT. MOD. and E terminals to produce 30% modulation depth within the modulation frequency range 100 Hz to 10 kHz.
(5) Release the METER READS key switch and, if necessary, repeat (2) above.

2.5.3 FREQUENCY MODULATION

In addition to the MOD. SELECTOR switch, there are three other controls concerned in setting up the carrier deviation when the output from the Signal Generator is to be frequency modulated. These controls are the continuously-variable SET MOD. potentiometer, the DEVIATION RANGE switch, and the DEVIATION—NORMAL/HIGH switch. When the METER READS key switch is held to F.M., the panel meter indicates deviation. The meter has two deviation scales: one calibrated from 0 to 5 kHz, and the other from 0 to 15 kHz.

With the DEVIATION—NORMAL/HIGH switch set to NORMAL, the meter scale appropriate to the setting of the DEVIATION RANGE switch is used and the

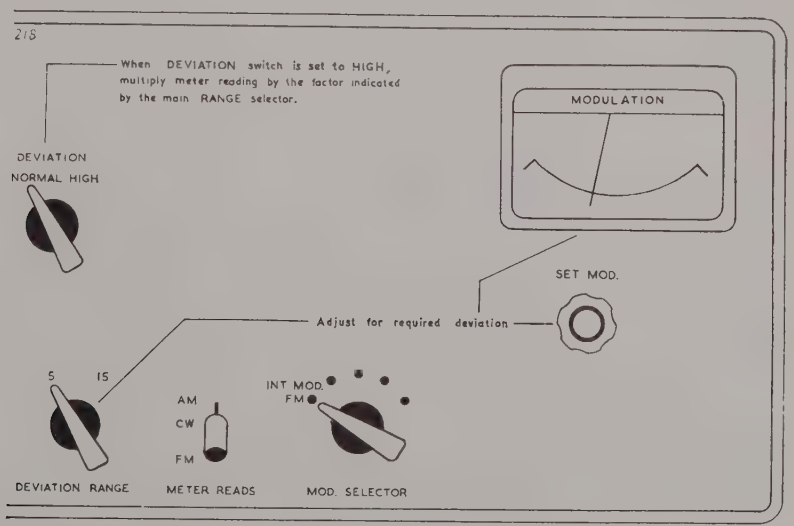


Fig. 2.6 (b)
Internal f.m. operation
(ii) Setting deviation

TABLE 2

RANGE switch setting (MHz)	*DEVIATION RANGE switch setting (kHz)*	*DEVIATION—NORMAL/HIGH switch set to HIGH*	
		Multiply meter reading by	*Maximum deviation obtainable (kHz)*
0·2–13·5 (Band 1)	5	2	10
	15	2	30
13·5–27·5 (Band 2)	5	1	5
	15	1	15
27–55 (Band 3)	5	2	10
	15	2	30
54–110 (Band 4)	5	4	20
	15	4	60
108–220 (Band 5)	5	8	40
	15	8	120

deviation is as indicated by the meter for all settings of the carrier-frequency RANGE switch.

With the DEVIATION—NORMAL/HIGH switch set to HIGH, the deviation obtained on the 13·5- to 27-MHz band is the same as with the switch set to NORMAL. For all other carrier-frequency bands the deviation is increased and the meter readings—again taken on the scale appropriate to the settings of the DEVIATION RANGE switch—must be multiplied in accordance with Table 2 above.

The following example shows the method of determining the meter reading for a required deviation greater than 15 kHz and thus necessitates setting the DEVIATION—NORMAL/HIGH switch to HIGH.

Example: A deviation of 36 *kHz is required at a carrier frequency of* 80 *MHz.*

The carrier frequency lies within the 54- to 110-MHz band. The meter multiplying factor for this band is 4; therefore, for 36-kHz deviation, the meter should be set (by means of the SET MOD. control) to read

$$\frac{36}{4} = 9 \text{ kHz}.$$

Do this on the bottom scale of the meter with the DEVIATION RANGE switch set to 15 kHz.

(a) F.M. from the internal 3-frequency oscillator

(1) Set the MOD. SELECTOR switch to INT. MOD.—F.M.

(2) Turn the SET MOD. FREQ. switch to give the required modulation frequency—400, 1,000, or 1,500 Hz.

(3) Set the DEVIATION RANGE switch as required. If, at carrier frequencies less than 13·5 MHz, or greater than 27·5 MHz, more than 15 kHz deviation is required, set the DEVIATION—NORMAL/HIGH switch to HIGH. (Deviations greater than 15 kHz are not obtainable on the 13·5- to 27·5-MHz carrier-frequency band, the maximum deviations obtainable on the other carrier-frequency bands are given in Table 2.)

(4) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.

(5) With the METER READS key switch held to F.M., adjust the SET MOD. control until the required deviation is indicated on the panel meter; read the meter on its middle scale when the DEVIATION range switch is at 5 kHz, and read on the lower scale when the switch is at 15 kHz. If the DEVIATION—NORMAL/HIGH switch is set to HIGH, the meter readings must be multiplied by the appropriate factor given in Table 2.

(6) Release the METER READS key switch and, if necessary, repeat (5) above.

(b) F.M. from an external source

(1) Set the MOD. SELECTOR switch to EXT. MOD.—F.M.

(2) Set the DEVIATION RANGE switch as required. If at carrier frequencies less than 13·5 MHz, or greater than 27·5 MHz, more than 15 kHz deviation is required, set the DEVIATION—NORMAL/HIGH switch to HIGH. (Deviations greater than 15 kHz are not obtainable on the 13·5- to 27·5 MHz carrier-frequency band; the maximum deviations obtainable on the other carrier-frequency bands are given in Table 2.)

(3) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.

(4) Couple the external modulation source to the EXT. MOD. and E terminals.

(5) With the METER READS key switch held to F.M., adjust the SET MOD. control until the required deviation is indicated on the panel meter; read

the meter on its middle scale when the DEVIATION RANGE switch is set to 5 kHz, and read on the lower scale when the switch is set to 15 kHz. If the DEVIATION—NORMAL/HIGH switch is set to HIGH, the meter readings must be multiplied by the appropriate factor given in Table 2.

For any settings of the DEVIATION RANGE and DEVIATION—NORMAL/HIGH switches, and within the modulation frequency range 50 Hz to 15 kHz, approximately 25 volts r.m.s. is required between the EXT. MOD. and E terminals for full deviation. With respect to 1 kHz, the frequency characteristic of the modulation system is flat to within $\pm$ 1 dB from 50 Hz to 15 kHz.

2.5.4 SIMULTANEOUS FREQUENCY AND AMPLITUDE MODULATION

(1) Set up the required depth of amplitude modulation as detailed in Section 2.5.2 (a).

(2) Leaving the MOD. SELECTOR switch at INT. MOD. —A.M., and without altering the setting of the SET MOD. control, set up the required deviation in a similar manner to that detailed in Section 2.5.3 (b); in this case, adjust the amount of deviation by variation of the audio input from the external modulation source.

2.6 R.F. OUTPUT ARRANGEMENTS

Five factors affect the output level from the Signal Generator:—

(a) The SET CARRIER control whose setting determines the input level to the attenuator cascade.

(b) The ' coarse ' or OUTPUT VOLTAGE attenuator.

(c) The ' fine ' or MULTIPLY BY attenuator.

(d) The TERMINATING UNIT which plugs on the end of the output cable from the fine attenuator.

(e) ATTENUATOR PAD Type TM 5552, which is an optional accessory designed for insertion between the output cable and TERMINATING UNIT when especially low output levels are required.

The SET CARRIER control is adjusted in conjunction with the panel meter; with the METER READS key switch in its central position, the panel meter forms part of a crystal voltmeter which monitors the input to the coarse attenuator. The panel meter has three main marks on its scale; these marks are — 1dB, SET R.F., and +1 dB, respectively. Normally, the SET CARRIER control should be adjusted to bring the meter pointer to the SET R.F. mark.

Four 20-dB steps give the coarse or OUTPUT VOLTAGE attenuator a total range of 80 dB; each setting of the attenuator control has markings in yellow and in white, the yellow markings being in decibels relative to 1 μV; the white markings are directly in units of voltage.

Ten 2-dB steps give the fine or MULTIPLY BY attenuator a total range of 20 dB; each setting of the attenuator control has markings in yellow and white, the yellow markings being in terms of decibels relative to 1 μV, and the white markings multiplying factors for the white voltage markings on the coarse attenuator.

Both attenuators have a characteristic impedance of 75 ohms and, ' looking into ' the coaxial socket at the end of the output cable, the instrument appears as a generator with a source impedance of 75 ohms at all attenuator settings.

The TERMINATING UNIT is, essentially, a 6-dB attenuator pad; ' looking into ' its input socket, with its output sockets unterminated, the TERMINATING UNIT presents an impedance of 75 ohms, while the two outlets present impedances of 52 and 75 ohms respectively.

The ATTENUATOR PAD has a characteristic impedance of 75 ohms and provides an optional, additional, 20-dB attenuation of the output signal.

It should be noted particularly that the r.f. output controls on the Signal Generator are calibrated in terms of source e.m.f. or open-circuit output voltage. The significance of quoting the output of a signal generator in this way will be apparent when it is remembered that one of the primary functions of a signal generator is to simulate a received signal as it would come from an aerial.

To take a simple case—that in which a 75-ohm receiver is fed from a 75-ohm dipole—the e.m.f. induced in the aerial is shared between its inherent 75-ohm radiation resistance and the matched 75-ohm receiver input. Clearly, when the same receiver is fed from a signal generator, the corresponding signal strength is given by the source e.m.f. of the signal generator, and not by the on-load p.d. at the receiver terminals.

2.6.1 OUTPUTS FROM 1 μV TO 100 mV AT 52 AND 75 OHMS

It is intended that the Signal Generator should normally be used with the SET CARRIER control adjusted to bring the meter pointer to the SET R.F. mark; with the TERMINATING UNIT coupled directly to the output cable; and without the ATTENUATOR PAD Type TM 5552.

Used in this way, the Signal Generator should be regarded as a source of zero impedance in series with a resistance of either 75 ohms or 52 ohms, the open-circuit output level, or source e.m.f., being variable in 2-dB steps from 1 μV to 100 mV and being given:

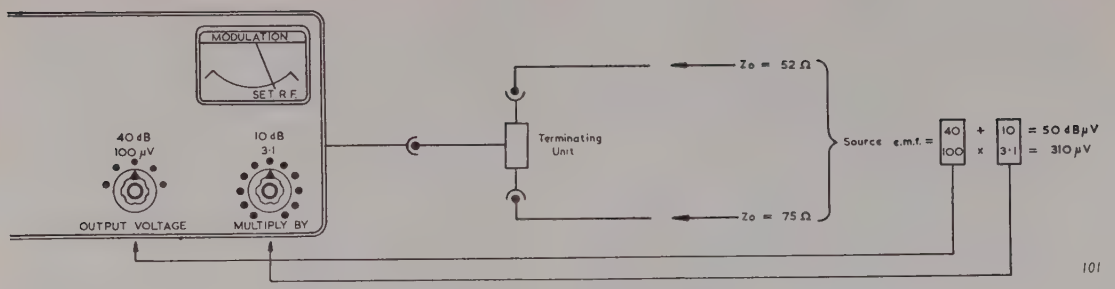


Fig. 2.7 Outputs via terminating unit

(a) *directly in terms of decibels relative to* 1 μV, by the sum of the yellow settings of the OUTPUT VOLTAGE and MULTIPLY BY attenuators;

(b) *directly in voltage*, by the product of the white settings of the OUTPUT VOLTAGE and MULTIPLY BY attenuators.

The +1-dB and −1-dB marks on the panel meter allow interpolation between the 2-dB steps of the MULTIPLY BY attenuator. Setting the meter pointer to either the +1-dB or −1-dB mark increases or decreases the input to the attenuator cascade by 1 decibel. Thus, using the SET CARRIER control and panel meter in conjunction with the OUTPUT VOLTAGE and MULTIPLY BY attenuators, the output level from the Signal Generator can be varied in 1-dB steps over the range 0 to +100 dB relative to 1 μV.

It should be noted that the white voltage indication given by the attenuator controls is not directly applicable when the meter is set to other than the SET R.F. mark; with the meter at −1 dB, the source e.m.f. at the TERMINATING UNIT outlets is 0·89 of the indicated voltage; with the meter at +1 dB, the source e.m.f. is 1·12 of the indicated voltage.

2.6.2 OUTPUTS FROM 2 μV TO 200 mV AT 75 OHMS ONLY

With the TERMINATING UNIT detached and with the meter at the SET R.F. mark, the output level obtained directly from the plug at the end of the r.f. output cable is variable in the range 2 μV to 200 mV and is derived via a source impedance of 75 ohms.

Under these conditions, the open-circuit level, or source e.m.f., in terms of decibels relative to 1 μV is obtained by adding 6 dB to the sum of the meter reading and the yellow indications of the OUTPUT VOLTAGE and MULTIPLY BY attenuators; the source e.m.f. is given directly in voltage by doubling the product of the white indications of the OUTPUT VOLTAGE and MULTIPLY BY attenuators.

2.6.3 OUTPUTS FROM 0.1 μV TO 10 mV AT 52 AND 75 OHMS

With the TERMINATING UNIT coupled to the r.f. output cable via the optional 20-dB ATTENUATOR PAD and with the meter at the SET R.F. mark, the output level from the TERMINATING UNIT is variable in the range 0·1 μV (nominal) to 10 mV.

In this case, the source e.m.f. in terms of decibels relative to 1 μV is obtained by subtracting 20 dB from the sum of the meter reading and the yellow indications of the OUTPUT VOLTAGE and MULTIPLY BY attenuators; the source e.m.f. is given directly in voltage by dividing the product of the white indications of the OUTPUT VOLTAGE and MULTIPLY BY attenuators by 10.

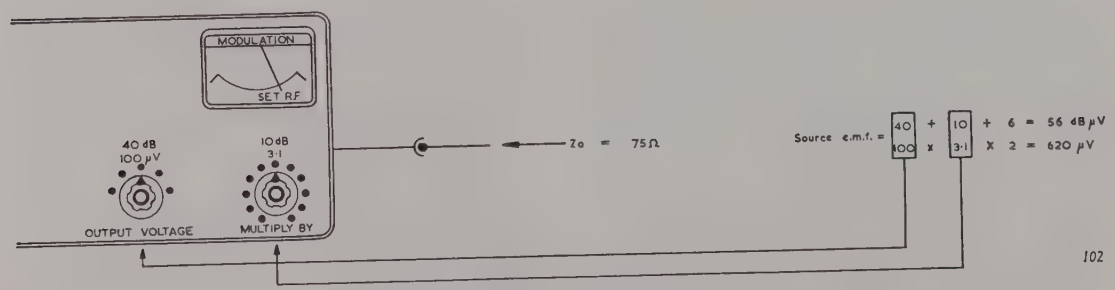


Fig. 2.8 Output direct from output lead

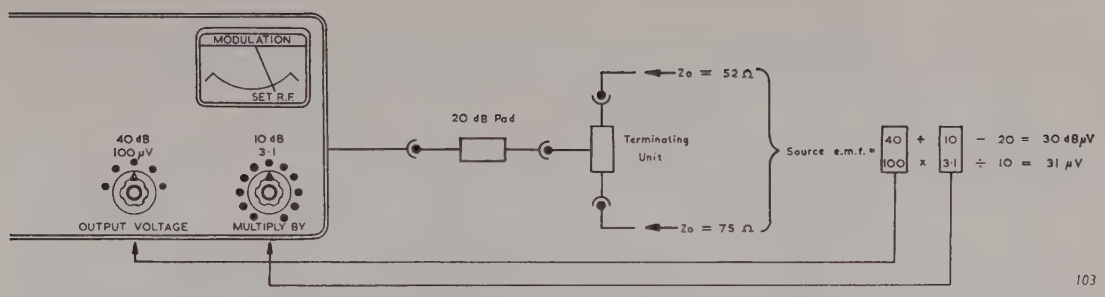


Fig. 2.9 Outputs via 20-dB pad and terminating unit

2.6.4 OUTPUT IN TERMS OF VOLTAGE DEVELOPED ACROSS AN EXTERNAL LOAD

For some particular applications, it may be desired to work not in terms of source e.m.f. as indicated by the meter and attenuator controls, but in terms of actual voltage developed across the external load. This on-load, or terminal voltage, is given by the expression

$$V_L = E \times \frac{Z_L}{Z_0 + Z_L} \qquad \text{.....(1)}$$

where V_L = actual voltage developed across the external load.

E = the source e.m.f. of the Signal Generator.

Z_L = the impedance of the external load.

Z_0 = the source impedance of the Signal Generator; (with the TERMINATING UNIT in use, $Z_0 = 75$ or 52Ω; with the TERMINATING UNIT removed, $Z_0 = 75\Omega$).

A series of multiplying factors, which can be used to convert from source e.m.f. to actual voltage developed across an external *resistive* load, and which have been derived with the aid of the above expression, are given in Table 3 for a selection of typical load values.

2.6.5 MATCHING TO EXTERNAL LOADS OTHER THAN 52 OR 75 OHMS

The TERMINATING UNIT supplied with the Signal Generator allows r.f. outputs to be obtained from a source impedance of either 52 or 75 ohms.

If the equivalent under test has an input impedance of other than 52 or 75 ohms, and if it is required to present the equipment with a signal derived from a matched source, then it is necessary to modify the output arrangements of the Signal Generator. The simple modifications required are described in sub-sections (a) and (b) which follow.

These expressions are based on the assumption that the external load impedance Z_L is essentially resistive. Where Z_L is not essentially resistive, it may be necessary for the user to revise these expressions to take account of the reactive component of the load.

In these sub-sections it is assumed that the TERMINATING UNIT is in circuit, and that the 20-dB ATTENUATOR PAD is out of circuit.

(a) External load less than that of the TERMINATING UNIT outlet in use.

The impedance presented to the load can be made equal to the load impedance by shunting the TERMINATING UNIT outlet with a single resistor, R_p, where

$$R_p = \frac{Z_0 \times Z_L}{Z_0 - Z_L} \qquad \text{.....(2)}$$

TABLE 3

External load impedance in ohms	*Approximate multiplying factor to convert from source e.m.f. to actual voltage developed across an external resistive load*	
	Z_0 75Ω	Z_0 52Ω
10	0·12	0·16
20	0·21	0·28
30	0·29	0·36
40	0·35	0·43
50	0·4	0·49
52	0·41	0·5
60	0·44	0·53
70	0·48	0·57
75	0·5	0·59
80	0·51	0·61
100	0·57	0·65
150	0·67	0·74
200	0·73	0·79
300	0·8	0·85
600	0·89	0·92

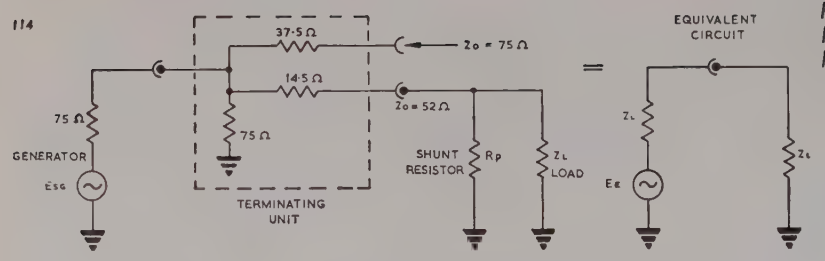


Fig. 2.10 Matching to low-impedance loads

and where Z_0 = the source impedance of the Signal Generator at the TERMINATING UNIT outlet in use;

Z_L = the impedance of the external load.

Under these conditions, the relationship between E_{SG}, the e.m.f. indicated by the attenuator controls on the Signal Generator, and E_E, the effective source e.m.f. presented to the external load, is given by the expression

$$E_{SG} = E_E \times \frac{R_p + Z_0}{R_p} \quad \text{.....(3)}$$

Example: It is required to provide a signal of 25 μV effective source e.m.f. at a source impedance of 20 ohms.

Since the new source impedance is to be 20 ohms, the output is taken from the 52-ohm outlet on the TERMINATING UNIT, the 52-ohm outlet being chosen in preference to the 75-ohm outlet to obtain the minimum reduction from E_{SG} to E_E.

From expression (2), the value of R_p to be connected in parallel with the 52-ohm outlet of the TERMINATING UNIT is

$$\frac{52 \times 20}{52 - 20} = 32{\cdot}5\,\Omega.$$

From expression (3), the attenuator controls on the Signal Generator should be set to indicate

$$25 \times \frac{32{\cdot}5 + 52}{32{\cdot}5} = 65\ \mu V.$$

The attenuators cannot be set to indicate exactly 65 μV and they should therefore be set to 63 μV—the setting nearest to the required value for E_{SG}. 63 μV is approximately −0·3 dB relative to 65 μV and, if desired, the user may obtain an E_{SG} nearer to 65 μV by adjustment of the SET CARRIER control to bring the meter pointer to an estimated +0·3 dB.

As a result of shunting the output of the TERMINATING UNIT with 32·5 ohms and setting the attenuator controls in the manner described, the equipment under test is fed from a source whose effective output impedance is 20 ohms and whose effective source e.m.f. is 25 μV; the actual voltage developed across the input impedance of the equipment under test is, of course, 12·5 μV.

(b) External load greater than that of the TERMINATING UNIT outlet in use.

The impedance presented to the load can be made equal to the load impedance by connecting a single resistor, R_S, in series with the Signal Generator output. The value of R_S is given by the expression

$$R_S = Z_L - Z_0 \quad \text{.....(4)}$$

where Z_L = the impedance of the external load.

Z_0 = the source impedance of the Signal Generator at the TERMINATING UNIT outlet in use.

Under these conditions, the effective source e.m.f. (E_E) of the Signal Generator and series resistor combined, equals the source e.m.f. (E_{SG}) of the Signal Generator alone, i.e.

$$E_{SG} = E_E \quad \text{.....(5)}$$

Example: It is required to provide a signal of 10 μV effective source e.m.f. at a source impedance of 300 ohms.

Since the new output impedance is greater than either 52 or 75 ohms, there is no advantage to be gained by using one of the TERMINATING UNIT outlets in preference to the other; in this example it is assumed that the 75-ohm outlet is used.

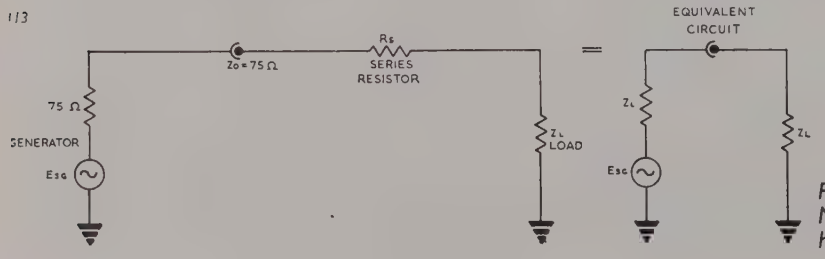


Fig. 2.11 Matching to high-impedance loads

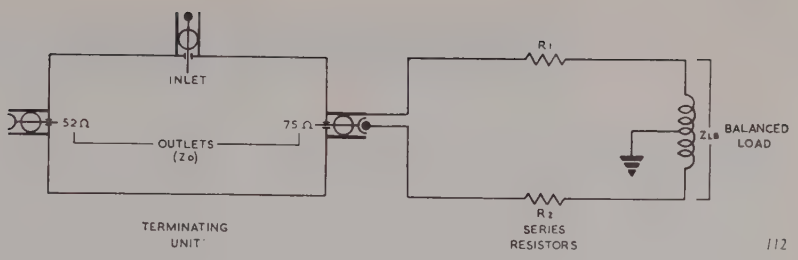


Fig. 2.12
Matching to balanced loads

From expression (4) the value of R_S to be connected in series with the 'live' connection between the Signal Generator and the equipment under test, is

$$300-75 = 225\Omega.$$

From expression (5), the attenuators on the Signal Generator should be set to indicate

$$10\ \mu V.$$

In this way, the equipment under test is fed from a source whose effective impedance is 300 ohms and whose effective source e.m.f. is 10 μV; the actual voltage developed across the input impedance of the equipment under test is, of course, 5 μV.

2.6.6 MATCHING TO BALANCED LOADS

The preceding Sections dealing with r.f. output arrangements are based on the supposition that the equipment being fed from the Signal Generator has an unbalanced input circuit.

With certain types of equipment, the input circuit is in the form of a balanced winding; such equipment can be fed from the unbalanced output of the Signal Generator by interposing two loading resistors between the TERMINATING UNIT outlet and the ends of the balanced input winding. This method makes use of the auto-transformer effect of the centre-tapped winding, and is *not* suitable for resistive balanced inputs.

One resistor, R_1, is connected in series between the earth connection of the TERMINATING UNIT outlet in use and one side of the balanced winding; the other resistor, R_2, is connected in series between the 'live' connection of the TERMINATING UNIT outlet in use and the other side of the balanced winding.

Values for R_1 and R_2 may be computed from the following expressions:

$$R_1 = \frac{Z_{LB}}{2} \qquad \text{.....(6)}$$

$$R_2 = \frac{Z_{LB}}{2} - Z_0 \qquad \text{.....(7)}$$

where Z_{LB} = the total line-to-line impedance of the balanced winding.

Z_0 = the source impedance of the Signal Generator at the TERMINATING UNIT outlet in use.

With the equipment under test and the TERMINATING UNIT of the Signal Generator interconnected via R_1 and R_2 as described above, the source e.m.f. (E_{SG}) indicated by the Signal Generator controls is equal to the effective line-to-line source e.m.f. (E_E) 'seen' by the equipment under test.

Example: It is required to match the 75-ohm outlet to a balanced winding whose total line-to-line impedance is 200 ohms.

From expression (6), the value of R_1 is

$$\frac{200}{2} = 100\Omega.$$

From expression (7), the value of R_2 is

$$\frac{200}{2} - 75 = 25\Omega.$$

R_1 is connected in series with the earth connection of the TERMINATING UNIT and one side of the balanced winding; R_2 is connected in series with the 'live' connection between the TERMINATING UNIT and the other side of the balanced winding.

2.7 SYNCHRONIZING SIGNAL

An audio sinewave signal, derived from the internal a.f. oscillator, is available between the SYNC and E terminals of the instrument when the MOD. SELECTOR switch is set at either of the INT. MOD. positions. The frequency of the signal will depend on the setting of the SET MOD. FREQ. switch; it has an open-circuit level which varies from about 30 volts at 400 Hz to about 100 volts at 1500 Hz, and is derived via a source impedance of approximately 250 kΩ.

When an output from the equipment under test is being viewed on a cathode-ray oscilloscope, it will often be found convenient to lock the c.r.o. time base directly with the SYNC signal rather than with the actual signal being viewed.

The SYNC output can, of course, also be used when an audio-frequency signal is required for the equipment under test.

Section 3

Operational summary

When the user is familiar with the principles and techniques of operation detailed in Section 2 of this manual, the following abridged operating instructions may be found convenient.

Check correctness of mains transformer tappings before use.

STANDARDIZING THE FREQUENCY SCALE

Switch mains ON and set RANGE switch to 13·5–27·5; with MOD. SELECTOR switch set to other than INT. MOD.—F.M. or EXT. MOD.—F.M., and using headphones plugged into CRYSTAL CHECK socket, tune main dial to crystal check point near centre of band. Bring movable cursor in line with dial calibration corresponding to crystal check point. Check accuracy of frequency indication above and below point to which cursor was originally set, equalize errors over band by readjusting cursor. *See Section* 2.4.2.

TUNING

Set RANGE switch to band required; rotate TUNE control until cursor indicates required frequency. For higher frequency-accuracy, compute relationship of frequency change to change in auxiliary dial setting between crystal check points or scale markings embracing required frequency. Starting from selected point below required frequency, rotate TUNE control so that incremental dial traverses calculated number of divisions. *See Sections* 2.4.1 *and* 2.4.4.

INCREMENTAL FREQUENCY ADJUSTMENT

Make small carrier changes by means of INC. FREQ. control, using multiplying factors as shown on front panel. *See Section* 2.4.3.

C.W. OPERATION

With MOD. SELECTOR switch set to C.W., adjust SET CARRIER to bring meter pointer to SET R.F.; adjust step attenuators to obtain required output level. *See Section* 2.5.1.

AMPLITUDE MODULATION

Internal:

With MOD. SELECTOR switch at INT. MOD.—A.M., select required modulation frequency on SET MOD. FREQ. switch, adjust SET CARRIER to bring meter pointer to SET R.F. With METER READS switch at A.M., adjust SET MOD. to bring meter pointer to required modulation depth. Release METER READS switch and, if necessary, readjust SET CARRIER; adjust step attenuators to obtain required output level.

External:

As for internal, except that MOD. SELECTOR switch is set to EXT. MOD.—A.M.; SET MOD. FREQ. switch is inoperative, and external signal is injected between EXT. MOD. and E terminals. Approximately 15 volts r.m.s. (100 Hz to 10 kHz) is required to produce 30% modulation. *See Section* 2.5.2.

FREQUENCY MODULATION

Internal:

With MOD. SELECTOR switch at INT. MOD.—F.M., select required modulation frequency on SET MOD. FREQ. switch. Set DEVIATION RANGE switch as required, and adjust SET CARRIER control to bring meter pointer to SET R.F. With METER READS switch at F.M., adjust SET MOD. to bring meter pointer to required deviation on meter scale appropriate to DEVIATION RANGE switch setting. (For deviations greater than 15 kHz, set DEVIATION—NORMAL/HIGH switch to HIGH and multiply meter readings by factor given in Table 2, Section 2.5.3.) Release METER READS switch and, if necessary, readjust SET CARRIER; adjust step attenuators to obtain required output level.

External:

As for internal, except that MOD. SELECTOR switch is set to EXT. MOD.—F.M., SET MOD. FREQ. switch is inoperative, and external signal is injected between EXT. MOD. and E terminals. Approximately 25 volts r.m.s. (50 Hz to 15 kHz) is required to produce full deviation. *See Section* 2.5.3.

SIMULTANEOUS FREQUENCY AND AMPLITUDE MODULATION

Set up as for Amplitude Modulation Internal. Then, with MOD. SELECTOR switch still set at INT. MOD.—A.M., apply external signal (50 Hz to 15 kHz) between EXT. MOD. and E terminals. Adjust level of external signal to produce required deviation; do not readjust SET MOD. control. *See Section* 2.5.4.

Section 4

Technical description

4.1 R.F. CIRCUITS

The r.f. oscillator itself (V3) is variable only over a fundamental frequency range of 4·5 to 9·16 MHz; the four higher frequency bands are obtained from a chain of four ganged harmonic multipliers (V6, V8, V10, and V12) giving multiplying factors of ×3, ×2, ×2, and ×2 respectively. The setting of the frequency RANGE switch determines which of the multipliers acts as the output stage. Output over the 0·2 to 13·5 MHz band is obtained by applying the 27 to 57 MHz output of the second multiplier to V7a which functions as a mixer. A 30 MHz signal from a crystal oscillator V16 is coupled via the mutual inductance of L20 into the grid circuit of the mixer stage V7a. The variable frequency is thus heterodyned with a fixed 30 MHz signal and the output from the mixer stage contains a difference frequency component which is utilised—after filtering and amplification by V7b—to provide outputs between 0·2 and 13·5 MHz.

The main tuning dial has five scales, all direct-reading in output frequency. To facilitate tuning, a slow-motion worm-and-wheel drive is incorporated; this control is fitted with a dial marked linearly from 0 to 100 to assist the operator in subdividing the frequency scales of the main tuning dial. In addition, there is a fine-tuning control. Fine tuning is achieved by varying the reactor-screen supply voltage. The frequency coverage on the highest-frequency band is approximately 24 kHz and proportionately less on the lower bands.

A carrier on/off switch (S11) is included to enable the r.f. signal to be interrupted without affecting the output circuits of the generator. This switch interrupts the h.t. supply to the screens of the multiplier valves for the band in use.

For all the r.f. bands, the output is taken via two resistive 75-ohm ladder-network attenuators in cascade. The first attenuator has a range of 80 dB and is variable in 20-dB steps; the second has a range of 20 dB in 2-dB steps. The input to the cascade is adjustable by means of the SET CARRIER control (R44), and is monitored by the MODULATION meter M1. The meter scale has a SET R.F. mark, and, respectively above and below this mark, + and —1-dB marks to allow interpolation between the 2-dB steps of the attenuator. The output from the second attenuator is applied to a coaxial cable which is permanently attached to the instrument; the direct open-circuit output obtainable from this

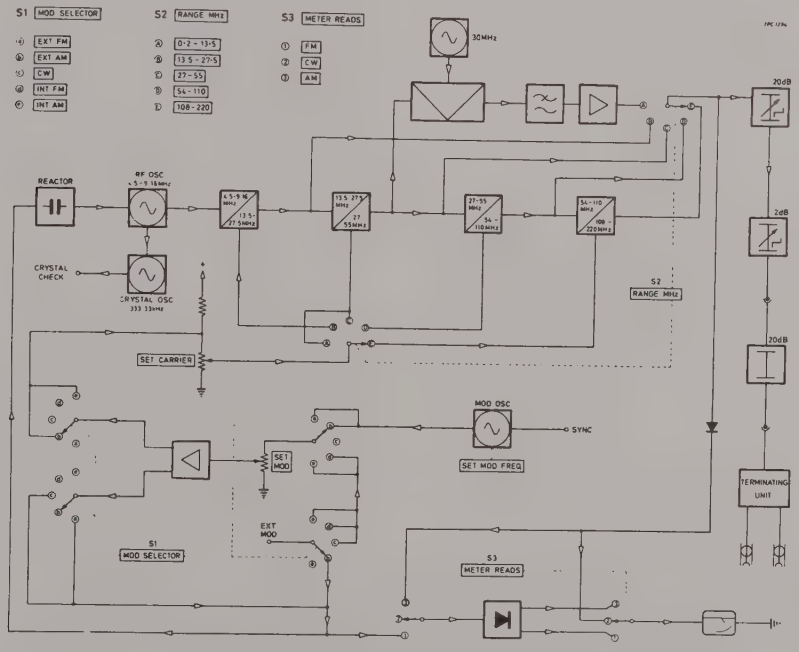


Fig. 4.1 Block schematic diagram

cable is at a source impedance of 75 ohms and is variable between 2 μV and 200 mV. By using the plug-on TERMINATING UNIT supplied, outputs 6 dB down on this range are obtainable at source impedances of both 75 and 52 ohms. With the optional ATTENUATOR PAD interposed between the output cable and the TERMINATING UNIT, outputs down to 0·1 μV are obtainable.

To provide for incremental carrier shift and for frequency modulation, a reactor valve (V2) is included in the tuned circuit of the r.f. oscillator. Movement of the INC. FREQ. controls (R112 and the S10 potentiometer network) varies the d.c. bias applied to the grid of V2, causing a change in its mutual conductance and thus a change in the r.f. oscillator frequency. Both the d.c. shift voltage and the a.f. modulating signal are applied to the grid of the reactor valve via a tracking potentiometer (R7); this is ganged to the main tuning capacitor so that the deviation or carrier shift is kept constant as the Signal Generator is tuned over any one band.

The built-in crystal calibrator—the crystal unit of which has a fundamental frequency of 333·3 kHz —is coupled to the variable-frequency r.f. oscillator and provides 14 checking points on each of the four upper frequency bands covered by the Signal Generator. The h.t. supply to the calibrator is automatically switched on by the insertion of a telephone plug into the CRYSTAL CHECK jack on the front panel; the heterodyne beats at the checking points may then be heard in the headphones or via the receiver under test. The cursor of the tuning dial is adjustable so that it may be set to correspond exactly with the nearest crystal checking point.

4.2 MODULATION SYSTEMS

Either internal or external a.f. modulation (f.m. or a.m.) may be applied; the SET MOD. FREQ. switch (S12) brings into circuit the appropriate tuning capacitor to give 400, 1,000, or 1,500 Hz modulation as required. For frequency modulation the a.f. signal passes through V5, switched as a cathode follower, and is applied to the reactor-valve input via the switched potentiometer network at S2ba and S2ca (part of the RANGE switch), and the tracking potentiometer R7. By this means, the ratio of the a.f. input voltage to f.m. deviation is maintained constant at all frequencies on each band, and is independent of the setting of either the RANGE switch or the TUNE controls.

The normal deviation ranges on all carrier bands are 0 to 5 kHz and 0 to 15 kHz. By means of the DEVIATION switch S5, the switched potentiometer system can be by-passed, thus enabling the deviation to be increased proportionally with increase in frequency multiplication and permitting a maximum deviation on the highest-frequency band of 15 × 8 = 120 kHz. On the 0·2- to 13·5-MHz band, the maximum deviation obtainable is 30 kHz.

Amplitude modulation to a depth continuously variable up to 50% is applied to the highest harmonic multiplier which is operating for the particular r.f. output band in use; this method helps to reduce the spurious frequency modulation often encountered when modulating an r.f. oscillator directly. The modulation is effected by supplying the anodes and screens of the multipliers from the tapped choke output of V5 which is switched to function as an a.f. amplifier.

Simultaneous amplitude and frequency modulation, for use, for example, when investigating the performances of limiter stages in f.m. receivers, is obtained by setting up the instrument for internal a.m. and then applying f.m. from an external source.

4.3 MONITORING ARRANGEMENTS

A two-stage amplifier-voltmeter provides monitoring facilities for a.m. depth and f.m. deviation. When S3 is switched to F.M., deviation is indicated on the panel meter by sampling the modulating voltages injected into the reactor valve V2: when switched to A.M., the input to the attenuators is sampled via the demodulating diode X2. When S3 is in the C.W. position, to which it is spring-biased, the voltmeter continuously monitors the r.f. input to the attenuators by means of its connection via the contacts S3b, and the silicon diode X2.

The design of the modulation monitoring circuits is such that with the Signal Generator set up for simultaneous a.m. and f.m., both percentage depth, and deviation, can be read independently.

4.4 POWER UNIT

The secondary winding of the mains transformer T4, in conjunction with the full-wave rectifier V11, provides for the positive d.c. h.t. requirements of the instrument; the h.t. supply to the reactor and r.f. oscillator valves is stabilized by means of a gas-filled stabilizer V9. The negative supply for the reactor-valve bias is drawn from a voltage-doubling circuit employing double-diode valve V15, and gas-filled stabilizer V14.

The primary of T4 is tapped to allow for operation from 100 to 150 volts, or 200 to 250 volts. Adequate filtering is introduced into the a.c. input circuit by means of the network C84, L24, C86 and C85, L25, C87.

Section
5

Maintenance

5.1 GENERAL

Section 4, TECHNICAL DESCRIPTION, of this manual deals with the internal circuits of the Signal Generator and it is strongly recommended that the user should familiarize himself with the principles described there before commencing the adjustment or replacement of component parts of the instrument.

The Circuit Diagrams show all the electrical components contained in the instrument together with their values. The full description of these components is given in the Replaceable Parts List, which also includes certain selected mechanical components.

The physical location of the electrical components is shown on the Component Layout Illustrations.

5.2 REMOVAL OF CASE

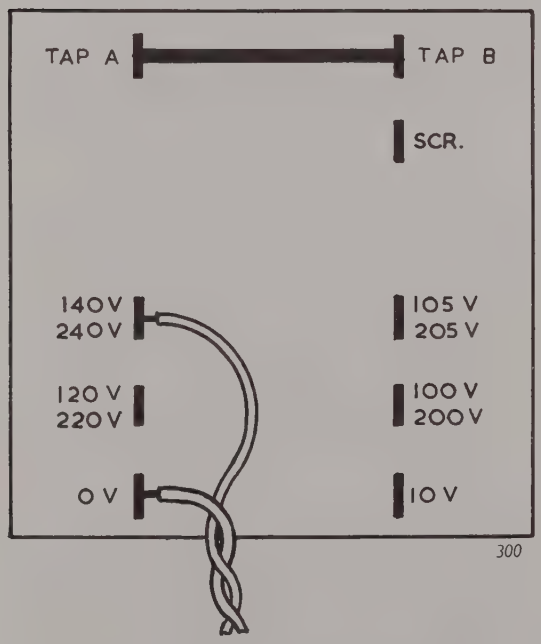
To remove the Signal Generator case:—

(1) Remove the screw securing the small plate in the left-hand side pocket; the mains lead is cleated to the case by means of this plate.
(2) Extract the eight screws from around the edge of the front panel.
(3) Pull the instrument clear of its case and disconnect the six-way interconnecting cable from the power unit chassis.
(4) Detach the screw, from the inside of the case, which holds the cleating plate for the r.f. output cable to the right-hand side pocket.
(5) After removing the seven screws from the underside of the case, lift out the power unit.

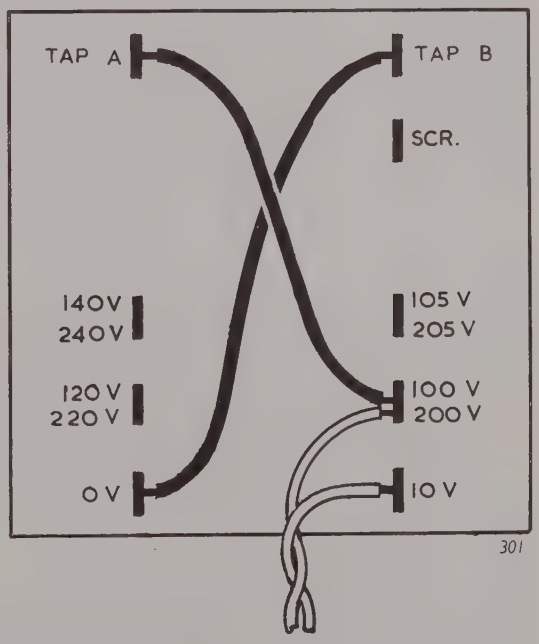
5.3 MAINS INPUT ARRANGEMENTS

The instrument is fitted with a mains transformer which has a double-wound primary; each primary section is tapped and the two sections can be connected in series-parallel for 100- to 150-volt operation or in series for 200- to 250-volt operation.

The 100- to 150-volt or the 200- to 250-volt range is selected by links on the coil of the transformer. Selection of intermediate voltages within either range is made by means of fly leads on the



(a) 240-volt connections



(b) 110-volt connections

Fig. 5.1 Mains transformer tappings

transformer tags. These tags are common to both ranges and are, therefore, annotated with two voltages; the applicable voltage depends on the position of the range links.

One fly lead must always be connected to either the '0' or the '10' tag; the other is connected to the tag whose voltage, added to 0 or 10 as appropriate, equals the mains supply voltage. Do not connect the fly leads to the tags marked TAP A or TAP B.

In order to examine the connections to the transformer and, if necessary, make adjustments, the instrument must be removed from its case in the manner described in Section 5.2. With the instrument out of its case, the transformer (T4 on Circuit Diagram, Fig. 8.2, and on Component Layout Illustration, Fig. 6.7) is immediately accessible.

For Supply Voltages within the range 200 to 250 volts, the tags on the transformer *must* be linked in the following manner:—

'TAP A' to 'TAP B'

For Supply Voltages within the range 100 to 150 volts, the tags on the mains transformer *must* be linked in the following manner:—

'0' to 'TAP B'
'100/200' to 'TAP A'

5.4 ACCESS TO ENCLOSED SUB-ASSEMBLIES

General tests or some peculiarity in the performance of the Signal Generator may suggest the desirability of inspecting the interior of one of the enclosed sub-assemblies which form part of the instrument. Any of these sub-assemblies can be dismantled by following the appropriate procedure as detailed in the sections below.

5.4.1 R.F. UNIT

To remove the screening cover from the r.f. unit:—

(1) Remove the instrument from its case and lay it face downwards.
(2) Extract the two screws which secure the screening cover of the r.f. unit.
(3) Grip the sides of the screening cover and draw it off; the cover is held by earthing contact springs and will consequently offer some resistance to removal.

5.4.2 'MULTIPLY BY' ATTENUATOR

A view of the MULTIPLY BY (fine) attenuator with the screening cover removed is shown in Component Layout Illustration, Fig. 6.6. To dismantle the attenuator:—

(1) Remove the attenuator screening cover after extracting the single securing screw.
(2) Remove the front-panel control knob after slackening the two grub screws which secure it to its associated spindle.
(3) Detach the main body of the attenuator from the front panel by extracting five screws; three of these screws are visible on removal of the control knob as in (2) above; the two remaining screws are located immediately above the 8-dB and 12-dB panel markings.

With the attenuator thus detached, it remains coupled to the body of the instrument by two coaxial leads; these leads are normally long enough to permit inspection and, if necessary, replacement of the attenuator resistors without completely disconnecting the attenuator.

Reassemble the attenuator in the reverse order to that detailed above.

5.4.3 'OUTPUT VOLTAGE' ATTENUATOR AND MONITOR DIODE

In addition to the actual attenuator components, the r.f. monitor diode, X2, and its associated filter components are mounted in the OUTPUT VOLTAGE attenuator casing. When dismantling the attenuator, the user should refer to Component Layout Illustration, Fig. 6.6. Access to the diode, X2, resistors R71 and R72, and capacitors C88, C89, and C90 can be obtained by removing the cover of the attenuator in the following manner:

(1) Disconnect R70 from the small insulated spigot projecting through the cover of the attenuator.
(2) Remove the central securing screw and lift the screening cover clear of the attenuator body.

To obtain access to the attenuator resistors, R73 to R82, detach the attenuator from the front panel of the Signal Generator in the following manner:—

(3) Remove the control knob by slackening the two grub screws securing it to its spindle.
(4) Extract the five fixing screws securing the attenuator to the front panel; three of these screws are immediately visible on removing the control knob as in (3) above; the two remaining screws are located immediately above and to the right of the coarse-attenuator panel markings.

With the attenuator detached as in (4) above, it remains coupled to the body of the instrument by two coaxial cables. These cables are, however, long enough to permit inspection and, if necessary, replacement of the attenuator-resistors without completely disconnecting the attenuator.

Reassemble the attenuator in the reverse order to that detailed above.

5.4.4 MAINS INPUT FILTER UNIT

To gain access to the components comprising the mains input filter:—

(1) Remove the nut and screw which secure, at the open end, the two halves of the mains filter unit screening cover.
(2) Separate the push-fit screening channel from the fixed half of the screening cover.

Reassemble the screening cover in the reverse order to that detailed above.

5.4.5 POWER UNIT

To remove the power unit from the instrument case:—

(1) Remove, from the underside of the instrument case, the five screws which engage with nuts along the front and left-hand flanges of the power unit chassis.
(2) Holding the power unit with one hand, remove the remaining two screws which engage with the tapped bushes on the right-hand flange of the power unit.

Replace the power unit in the reverse order to that detailed above.

5.5 WORKING VOLTAGES

The voltages given in this section for guidance when servicing the instrument were obtained from measurements made with a 20,000 ohms/volt meter on a representative Signal Generator Type TF 995B/5.

Primary winding of T4 (Supply Voltage) 240 volts a.c.
H.T. secondary winding and chassis 260–0–260 volts a.c.
Heater winding LTR 5 volts a.c.
Heater winding LT 6·3 volts a.c.
Pin 1 on plug PL1 and chassis 260 volts d.c.
Junction of R117/R118 and chassis —85 volts d.c.
Junction of L16/L17 and chassis 280 volts d.c.
Cathode of V11 and chassis 295 volts d.c.

Table 4 lists certain valve electrode voltages in the TF 995B/5. When checking the instrument against these voltages, the MOD. SELECTOR switch should be set to INT. MOD.—A.M., the RANGE switch (unless otherwise specified) should be set to 108–220 MHz, and the SET CARRIER and SET MOD. controls should be turned to their maximum and minimum settings respectively.

TABLE 4

Valve No.	V_a	V_{g2}	V_k
V1	245	50	1·5
V2	150	150	4
V3	150	95	—
V4	27	27	—
V5	250	250	3·0*
V6	130	160	—
V7†	Pin 1 235	—	—
V7†	Pin 6 250	—	2·5
V8	105	155	—
V9	150	—	—
V10	150	150	—
V11‡	Pin 4 260	—	295
	Pin 6 260	—	—
V12	150	150	—
V13	Pin 1 260	—	Pin 3 130
V13	Pin 6 85	—	Pin 8 18

**The cathode potential of V5 will increase to 40 volts when the MOD. SELECTOR switch is set to INT. MOD.—F.M.*

†*When checking the voltages on V7, set the RANGE MHz switch to 0·2–13·5.*

‡*All voltages shown are d.c. except for V11 anodes.*

Table 4 lists certain valve electrode voltages in the TF 995B/5. When checking the instrument against these voltages, the MOD. SELECTOR switch should be set to INT. MOD.—A.M., the RANGE switch (unless otherwise specified) should be set to 108–220 MHz, and the SET CARRIER and SET MOD. controls should be turned to their maximum and minimum settings respectively.

5.6 REPLACEMENT OF VALVES AND SEMICONDUCTORS

The types of valve used in the instrument, their base connections, and some guidance as to suitable alternatives if the types originally fitted are not readily available, are given in Table 5.

The valves and semiconductor diodes may normally be replaced without special selection. Valves V1, V5, V9, V11, and V13 to V15 are immediately accessible on removing the instrument from its case. To gain access to the 333·3-kHz oscillator crystal, X1, and to the remaining valves, remove the R.F. Unit screening cover. The crystal diode, X2, forms part of the OUTPUT VOLTAGE attenuator assembly and can be removed by the procedure detailed in Section 5.4.3.

Replacement of valves or semiconductors may necessitate either the reselection of associated components or readjustment of associated preset controls; aspects of this reselection and readjustment are discussed in the following Section.

5.7 PRESET AND SPECIALLY SELECTED COMPONENTS

During the factory calibration of the instrument, certain of its performance characteristics are brought within fine limits by means of preset components. Following the replacement or aging of certain fixed components, it may become necessary to repeat the calibration procedure by which the presets were adjusted.

The Description column of the Replaceable Parts List shows which of the components are of the

TABLE 5

Any valve which becomes faulty should preferably be replaced by a valve of the type originally supplied in the instrument and designated in the following table. If this is not possible, the additional data given by the table may be used as a guide to suitable alternatives.

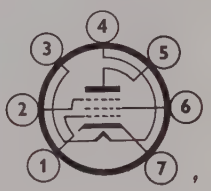
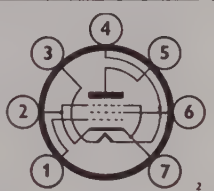
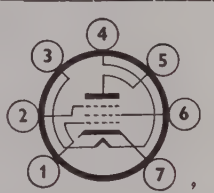
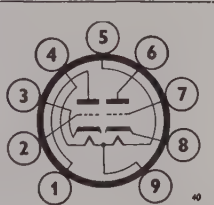
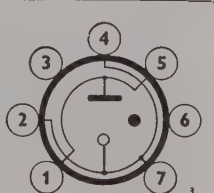
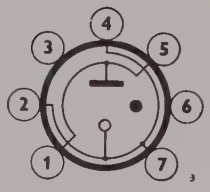
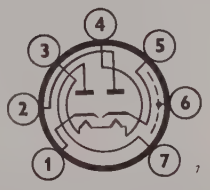
Valve	*Type*	*Base*	*British Commercial Equivalent*	*British Services Equivalent*	*U.S. Equivalent*
V1	6AK6 Power Pentode	 (B7G)		CV1762	6AK6
V2, V4, V6, V8, V10, V12, V16	6AK5 H.F. Pentode	 (B7G)	EF95	CV850	6AK5
V3	EF86 Pentode	(B9A)	2729	CV2901	6267
V5	6AU6 Pentode	 (B7G)	EF94	CV2524 CV4023	6AU6
V7, V13	12AT7 Double Triode	 (B9A)	ECC81	CV455	12AT7
V9	OA2 Voltage Stabilizer	 (B7G)	OA2 150C2 150C4 QS1207	CV1832 CV4020	OA2

TABLE 5 (continued)

Valve	*Type*	*Base*		*British Commercial Equivalent*	*British Services Equivalent*	*U.S. Equivalent*
V11	5Z4G Full-Wave Rectifier		(IO)	R52 GZ30 52KU U50	CV1863	5Z4G
V14	5651 Voltage Stabilizer		(B7G)	QS1209 QS83/3 85A2	CV2573 CV449	5651 OG3
V15	6AL5 Double Diode		(B7G)	D77 6D2 D152 DD6 EB91	CV140	6AL5

preset type; components which are individually selected are distinguished in that column by a single asterisk.

If, in servicing a TF 995B/5, it is necessary to replace any of these components, it will also be necessary, if the performance or accuracy of the instrument is not to be impaired, to repeat the factory calibration procedure by which the components were originally selected.

Section 5.8 gives a range of tests by which the main points of the performance of the instrument can be checked; this section also deals with the adjustment of preset components and with the choice of value for individually selected components.

It will be appreciated that it may sometimes be necessary to reselect a selected component even though that component itself has not been found faulty and replaced in initial servicing operations. To take an example—the internal modulation oscillator is tuned to 1,000 Hz by T1 and C6. In manufacture, C6 is selected to give an oscillator frequency of 1,000 Hz $\pm$ 5%. In servicing the instrument it might be found that T1 was faulty but that C6 was not. If T1 was replaced then it

TABLE 6

Component	*Section Describing Adjustment or Selection*	*Component*	*Section Describing Adjustment or Selection*
R19	5.8.10	C6	5.8.9
R39	5.8.17	C35	5.8.5
R70	5.8.8	C40	5.8.7
R119	5.8.13	C47	5.8.6
R127	5.8.12	C59	5.8.7
R128	5.8.12	C66	5.8.6
R129	5.8.12	C76	5.8.6
R130	5.8.16	C83	5.8.6
R131	5.8.11	C93	5.8.4
R132	5.8.13	C101	5.8.9
R133	5.8.13	C102	5.8.9
R134	5.8.11	L18	5.8.6
R136	5.8.12	L22	5.8.6
R138	5.8.12	L23	5.8.6
R140	5.8.12	T2	5.8.5
R163	5.8.13	T3	5.8.6

would be quite likely that with the original C6 the oscillator frequency would be outside the specified limits of ± 5% and that a new value of capacitance would have to be chosen.

It therefore follows that, in all servicing involving replacement of components, the user should consider carefully the possible effects on the performance of the stage or stages involved.

Table 6 on page 29 lists the circuit reference numbers of both types of component together with the numbers of the sections in which their adjustment or selection is described.

5.8 SCHEDULE OF TESTS

The following information, based on extracts from the internal Factory Test Schedule, is included to enable the user to carry out a series of tests by which the main points of performance of the instrument can be checked; it also gives details concerning the adjustment to preset components and the choice of value for individually selected components.

5.8.1 APPARATUS REQUIRED

(*a*) 750-volt Insulation Tester.

(*b*) Avometer, Model 8.

(*c*) Wave Analyser; Marconi Type TF 2330.

(*d*) Signal Generator, with standardized output; Marconi Types TF 801 (Series) or TF 995 (Series).

(*e*) Valve Voltmeter; Marconi Type TF 1041 (Series).

(*f*) Audio-Frequency Oscillator; Marconi Type TF 1101.

(*g*) Cathode-Ray Oscilloscope; Marconi Type TF 1330 (Series) or TF 2200 (Series).

(*h*) Deviation Meter; Marconi Type TF 791 (Series).

(*i*) Counter-type Frequency Meter; Marconi Type TF 1417/2.

(*j*) Crystal Calibrator.

(*k*) Standardized Wavemeter; Marconi Type TF 975.

(*l*) A.M. Communications Receiver, covering the range 0·2 to 220 MHz.

Note: *For the F.M. on C.W. check (Section* 5.8.18), *where deviations of less than* 50 *Hz have to be measured, it is essential that the deviation meter should be modified to operate from battery supplies, or incorporate facilities allowing its local oscillator to be brought under crystal control.*

5.8.2 INSULATION

(*Apparatus required: Item a*)

Test the insulation between each pin of the supply plug and chassis with SKT1 engaged with PL1. This reading should not normally be less than 40MΩ.

5.8.3 HUM LEVEL

(*Apparatus required: Item c*)

Measure the 100 Hz hum level at HT1 using a Wave Analyser isolated from the TF 995B/5 by a 4-μF capacitor. The hum level should not normally exceed 10mV.

5.8.4 CRYSTAL OSCILLATOR

(*Apparatus required: Items e and i*)

Plug headphones into the CRYSTAL CHECK socket and, by means of a loop of wire slipped over V4, take an output to the Counter-type Frequency Meter. Check the crystal frequency, it should usually lie between 333·266 Hz and 333·400 Hz. C93 may be padded with a value not exceeding 10 μμF to achieve this.

Using the Valve Voltmeter, measure the r.f. voltage across R27; it should normally lie between 8 and 15 volts.

5.8.5 BASIC OSCILLATOR

(*Apparatus required: Items e and k*)

Set the MOD. SELECTOR switch to C.W. and the RANGE switch to Band 2, 13·5 to 27 MHz. Coarse tune to 13·5 MHz (on Band 2) and adjust the dust core of T2 until the circuit oscillates at 4·5 MHz as indicated by the Wavemeter. Set the main tuning dial to 27 MHz and tune the trimmer C35 until the circuit oscillates at 9 MHz. Repeat these two adjustments for the most accurate frequency calibration; a calibration accurate to within ±1% is usually to be expected if this procedure is carried out. Check the tuning adjustments against the crystal by means of headphones plugged into the CRYSTAL CHECK jack socket.

Measure the r.f. voltages at the anode and grid of V3; these should be of the following order:—

	4·5 MHz	9·0 MHz
Grid	2·65 volts	9 volts
Anode	21 volts	41 volts

5.8.6 FREQUENCY MULTIPLIERS

(*Apparatus required: Item j*)

(1) 13.5- to 27-MHz band

Set the MOD. SELECTOR switch to C.W., the RANGE switch to 13·5–27 MHz, and the SET CARRIER control fully clockwise.

Set the main dial to 13·5 MHz, and adjust the core of T3 for maximum deflection on the panel meter. The SET CARRIER control, R44, should be readjusted if necessary.

Set the main dial to 27 MHz, and adjust C47 for maximum deflection on the meter.

Repeat these two adjustments several times until no further change is required, finishing with C47. Check that the output as indicated on the front-panel meter is sensibly constant over the whole band.

(2) 27- to 54-MHz band

Set the RANGE switch to 27–54 MHz, and the SET CARRIER control fully clockwise.

Set the main dial to 27 MHz, and adjust the spacing of the turns of L18 for maximum deflection on the panel meter. The SET CARRIER control should be readjusted if necessary.

Set the main dial to 54 MHz, and adjust C66 for maximum deflection on the meter.

Repeat these two adjustments several times until no further change is required, finishing with C66. Check that the output as indicated on the front-panel meter is sensibly constant over the whole band.

(3) 54- to 108-MHz band

Set the RANGE switch to 54–108 MHz and, using a similar procedure to (2) above, adjust L22 and then C76 at 54 and 108 MHz respectively.

(4) 108- to 220-MHz band

Set the RANGE switch to 108–220 MHz and, using a similar procedure to (2) above, adjust L23 and then C83 at 108 and 220 MHz respectively.

With the R.F. Box cover in position, check the frequency accuracy on all the above bands with the Crystal Calibrator. The frequency accuracy of the TF 995B/5 should be about $\pm 1\%$.

5.8.7 0.2- TO 13.5-MHz BAND

(*Apparatus required: Items j and l*)

This test must be made with the r.f. unit cover in position.

By means of a suitable jack plug, connect a pair of headphones to the CRYSTAL CHECK socket.

Set the RANGE switch to 0·2–13·5, and adjust the TUNE control to bring the 30 MHz main dial marking (on the 27–54 MHz arc) to the cursor; then, using the Crystal Calibrator, tune for zero beat.

With the SET CARRIER control in its fully clockwise position, adjust C40 and C59 alternately to give minimum deflection on the panel meter. These capacitors are accessible through two holes, slightly larger than the ventilation holes, in the top of the r.f. unit cover.

Connect the output of the Signal Generator to a receiver, and tune the receiver to some convenient accurately-known frequency between 0·2 and 13·5 MHz.

Set the main dial of the TF 995B/5 to this frequency, and adjust C40 for maximum receiver response.

In the absence of any other frequency standard, the receiver tuning may be standardized at frequencies between 4·5 and 9 MHz by loosely coupling its input to the basic oscillator of the TF 995B/5. This oscillator should first be standardized against the internal crystal calibrator, the basic-oscillator frequency being given by dividing by three the indication on the 13·5–27 scale.

5.8.8 R.F. OUTPUT VOLTAGE ACCURACY

(*Apparatus required: Item e*)

This test should be carried out with the instrument in its case.

Set the MOD. SELECTOR switch to C.W., and tune to 25 MHz. Set the OUTPUT VOLTAGE and MULTIPLY BY attenuators to give a joint indication of 100 dB above 1 μV (i.e. both fully clockwise). Connect the Signal Generator to the TERMINATING UNIT, and connect the 75-ohm outlet of the TERMINATING UNIT to the voltmeter. Adjust the SET CARRIER control to give an output level of 100 mV as indicated on the Voltmeter; if the front-panel meter pointer is not exactly at the SET R.F. mark, reselect R70.

Check that the output from the 52-ohm socket is also 100 mV. The maximum obtainable output over all bands should also be checked, it will usually be found to be greater than 1 dB above the SET R.F. mark.

5.8.9 MODULATION OSCILLATOR

(*Apparatus required: Items e, f and g*)

With the MOD. SELECTOR switch set to INT. MOD. —A.M. and the SET MOD. FREQ. control at 1,000, monitor the a.f. signal between the SYNC and E terminals. With the Cathode-Ray Oscilloscope, and using the Audio Oscillator as a standard frequency source, verify, by the method of Lissajous figures, that the oscillator frequency lies within the limits 1,000 Hz $\pm$ 5%. If it does not, reselect C6.

Check the modulation-oscillator frequency at 400 Hz and 1,500 Hz by the above method. If necessary, the following capacitors may have to be reselected to obtain the required frequencies: for 400 Hz modulation, C101; for 1,500 Hz modulation, C102.

5.8.10 F.M. DISTORTION

(*Apparatus required: Items c and h*)

Set the DEVIATION—NORMAL/HIGH switch to NORMAL, the DEVIATION RANGE switch to 15 kHz, the MOD SELECTOR switch to INT MOD—F.M., and the RANGE switch to 13.5–27; then adjust the SET CARRIER control to give a convenient deflection on the TF 995B/5 panel meter.

Connect the output cable directly to a carrier deviation meter, tune both instruments to 20 MHz, and adjust the TF 995B/5 attenuators for maximum output.

Adjust the SET MOD control to produce 15 kHz deviation, and check that the positive and negative deviations as indicated on the deviation meter are equal. If they are unequal, select a value for R19 to produce equal positive and negative deviations.

Apply the demodulated f.m. signal from the deviation meter to a wave analyser, and measure the total distortion at 13·5 MHz. The total f.m. distortion should not exceed 2%.

5.8.11 F.M. TRACKING AND RANGE 2 SENSITIVITY

(*Apparatus required: Items f and h*)

Set the MOD SELECTOR switch to EXT MOD—F.M., the DEVIATION RANGE switch to 15 kHz, and adjust the SET CARRIER control to bring the meter pointer to SET R.F. Set the OUTPUT VOLTAGE and MULTIPLY BY attenuators to 100 dB, connect the output cable directly to a deviation meter and tune both instruments to 13·5 MHz (range 2).

Connect the audio oscillator to the EXT MOD terminals and feed in a 20 V, 1 kHz signal. Turn the SET MOD control fully clockwise and check that the deviation indicated on the external deviation meter is at least 18 kHz adjusting R131, if necessary, to obtain this figure.

Turn the MOD SELECTOR switch to INT MOD F.M. and adjust the SET MOD control until the external deviation meter indicates a deviation of 15 kHz.

Tune both the TF 995B/5 and the deviation meter to 27 MHz (range 2). Note the deviation and, if necessary, adjust R134, so that the deviation is maintained at 15 kHz.

5.8.12 DEVIATION MONITOR

(*Apparatus required: Item h*)

Put the MOD SELECTOR switch to INT MOD—F.M. the DEVIATION–NORMAL/HIGH switch to NORMAL.

Turn the SET CARRIER control to give a convenient deflection on the TF 995B/5 output meter. Connect the output cable directly to a carrier deviation meter; and set the TF 995B/5 attenuator controls to give maximum output and tune both instruments to 20 MHz.

With the DEVIATION RANGE switch at 15 kHz and the METER READS switch at C.W. adjust the SET MOD control until 15 kHz deviation is indicated on the external deviation meter. Press the METER READS switch to F.M. and adjust R129 so that the deviation meter (M1) reads 15 kHz.

Return the METER READS switch to C.W. and turn the DEVIATION RANGE switch to 5 kHz. Adjust R127 to obtain 5 kHz deviation shown by the external deviation meter.

Press the METER READS switch to F.M. and adjust R128 so that the deviation meter (M1) reads 5 kHz.

Turn the RANGE switch to 27–54 MHz and tune the external deviation meter to the same frequency. Adjust the SET MOD control to give an indicated deviation of 15 kHz, with the DEVIATION RANGE switch at 15 kHz. Adjust R140 so that a true deviation of 15 kHz is obtained, as shown by the external deviation meter. Repeat this procedure on the 54–108 MHz and 108–220 MHz bands setting R138 and R136 respectively for true deviation of 15 kHz.

If a Deviation Meter is not available, the following method may be used to determine the frequency deviation. This method—the disappearing carrier method—depends upon the fact that the carrier, as opposed, of course, to the sidebands, disappears when the modulation index μ (the ratio of the frequency deviation δF to the modulation frequency f) has values of 2·4, 5·52, 8·65, 11·79, etc. Therefore, if the modulation frequency, f, is known, since deviation, δF, is equal to μf, deviation can be simply calculated when μ is known—i.e. at a carrier disappearance point. For example, if the applied modulation has a frequency of 10 kHz and the deviation is progressively increased until the carrier disappears, the deviation must be $2{\cdot}4 \times 10 = 24$ kHz, and again $5{\cdot}52 \times 10 = 55{\cdot}2$ kHz.

To determine these points, apply the output of the TF 995B/5 to a narrow-band (communication) a.m. receiver and tune the latter to the unmodulated output frequency of the TF 995B/5. Set the beat oscillator of the receiver to give an audio note; then frequency modulate the Signal Generator at a fairly high frequency outside the passband of the a.m. receiver—such as 10 kHz—starting from zero deviation and increasing the deviation until the beat with the carrier disappears. At this point the actual deviation can be calculated as described above.

5.8.13 THE INCREMENTAL FREQUENCY CONTROLS

(*Apparatus required: Items i and j*)

Check that the FINE INC. FREQ. dial is positioned so that the 0 coincides with the cursor when the

potentiometer wiper is at its mid-travel position. Switch to Band 2 and apply the Generator output to the Crystal Calibrator; tune, by means of the main tuning control, for a zero beat on the Calibrator. If necessary, reselect R119 so that there is no change in zero beat when C42 is short circuited; i.e. with the fine incremental frequency dial at zero, there should be zero volts on the wiper of R112.

At some convenient frequency, say 150 MHz, feed the output of the TF 995B/5 to the Electronic Counter and set the fine incremental frequency control to zero. Set the steps of the coarse incremental frequency control to be 20 kHz and 40 kHz by adjusting R133 on band 5. Repeat the procedure on Band 4, this time adjusting R132. Next, adjust R163 so that the fine incremental frequency control has a cover of 15 kHz on bands 5 and 4 and check that its calibrations are at 1-kHz intervals. It may be necessary to adjust R114 to obtain sufficient incremental shift.

5.8.14 HIGH DEVIATION

(*Apparatus required: Item h*)

Connect the output of the TF 995B/5 to a Deviation Meter and check that, when the TF 995B/5 is set for 9 kHz deviation with the DEVIATION—NORMAL/HIGH switch set to NORMAL, the indication on the meter rises to approximately the following values when the DEVIATION—NORMAL/HIGH switch is set to HIGH.

BAND	*RANGE MHz*	*HIGH Deviation for 9 kHz*
(1)	0·2–13·5	18 kHz
(2)	13·5–27·5	9 kHz
(3)	27–55	18 kHz
(4)	54–110	36 kHz
(5)	108–220	72 kHz

5.8.15 EXTERNAL F.M.

(*Apparatus required: Items f and h*)

Tune the Generator and Deviation Meter to a convenient frequency (say 20 MHz). Set the MOD. SELECTOR switch (S1) to EXT. MOD.—F.M. and apply a 1 kHz signal from the Audio Oscillator to the EXT. MOD. and E terminals of the TF 995B/5.

Bring the a.f. input voltage to a convenient point on the dB scale of the a.f. oscillator output monitor and adjust the SET MOD control to give a true deviation of 10 kHz as indicated on the external deviation monitor. Press the METER READS switch to F.M. and note the meter reading.

Vary the audio input frequency from 50 Hz to 15 kHz keeping the TF 995B/5 meter (M1) reading, obtained with the METER READS switch at F.M., constant at the previously noted value. This constant reading must be achieved by adjustment of the input voltage and not by variation of the SET MOD control. Monitor the corresponding deviation indicated by the external deviation meter. Check that the total variation of the input level and the true deviation does not exceed $\pm$ 1 dB.

5.8.16 INTERNAL A.M.

(*Apparatus required: Items g and l*)

Apply the output of the TF 995B/5 to a frequency changer circuit which is followed by an i.f. amplifier and Cathode Ray Oscilloscope; the i.f. amplifier should have a centre frequency which will allow its output to be viewed directly on the c.r.o. Set the MOD. SELECTOR switch to INT. MOD.—A.M. and adjust the SET MOD. control for 50% modulation as measured on the c.r.o. screen, using the formula:—

$$M(\%) = \frac{D_{max} - D_{min}}{D_{max} + D_{min}} \times 100\%$$

where D_{max} = the peak-to-peak dimensions of the c.r.o. display.

D_{min} = the trough-to-trough dimensions of the c.r.o. display.

Hold the METER READS switch to A.M. and check that the meter reading is correct. If not, adjust R130.

5.8.17 EXTERNAL A.M.

(*Apparatus required: Items f, g, and l*)

Set the MOD. SELECTOR switch (S1) to EXT. MOD.—A.M. and feed the output of the Audio Oscillator to the EXT. MOD. terminals of the TF 995B/5. Tune the Signal Generator to 20 MHz and view the modulation envelope as previously described.

Bring the a.f. input voltage to a convenient point on the dB scale of the a.f. oscillator monitor and adjust the SET MOD control to give a true modulation depth of 30%. Press the METER READS switch to AM and note the meter reading.

Vary the audio input frequency from 100 Hz to 10 kHz keeping the TF 995B/5 meter (M1) reading, obtained with the METER READS switch at AM, constant at the previously noted value. This constant reading must be achieved by adjustment of the input voltage, and not by variation of the SET MOD control. Measure the corresponding modulation depth with the oscilloscope; check that the variation of true modulation depth does not exceed 0.5 dB and that the variation of input voltage does not exceed 1 dB. If the variations exceed these limits select a new value for R39.

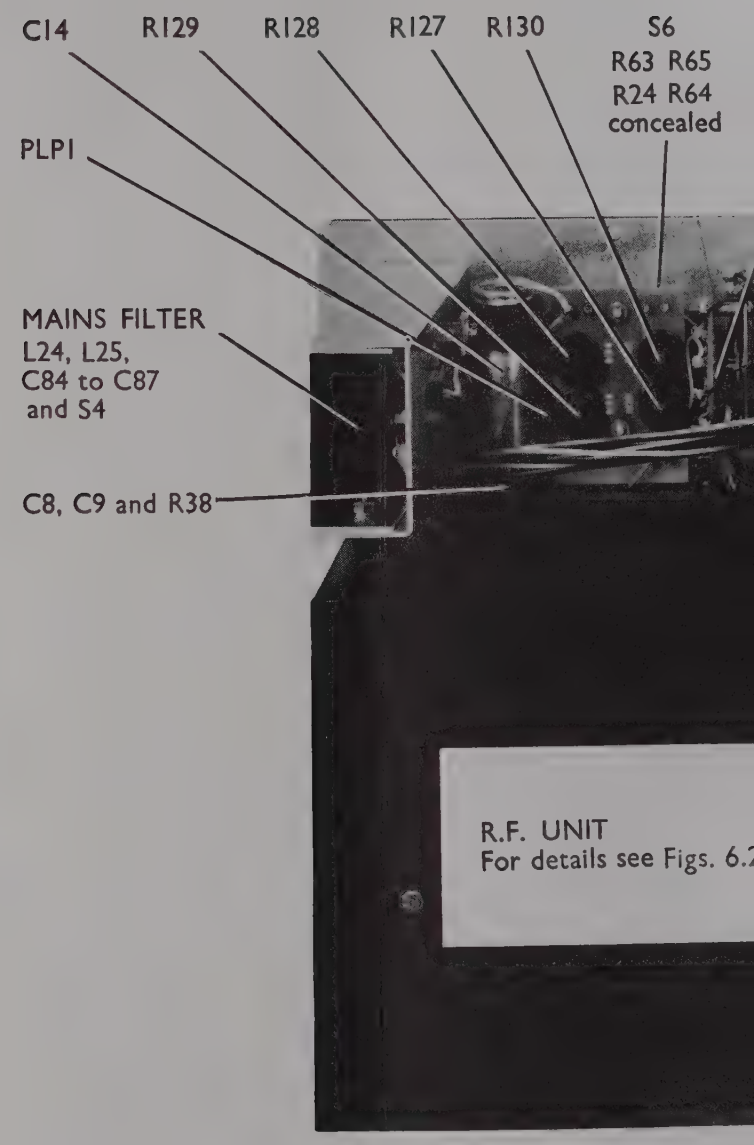
5.8.18 SPURIOUS F.M. ON C.W.

(*Apparatus required: Items c and h*)

To measure small amounts of spurious f.m., connect the Wave Analyser, Type TF 455 (Series), to the l.f. output of the Deviation Meter, using it as a tuned l.f. level indicator.

Note its level indication for a measured 2·5 kHz deviation; then, since the l.f. output of the monitor varies linearly with deviation, small amounts of f.m. may be calculated directly by noting the l.f. output level; for example, 25 Hz f.m. will give a level 40 dB below that for 2·5 kHz.

Switch to C.W. on the MOD. SELECTOR switch and, with the output level adjusted to the SET R.F. mark, check, at carrier frequencies of 90 and 216 MHz, that there is negligible frequency modulation of the signal; the spurious deviation is not likely to exceed 25 Hz.



NOTE R127 is now a fixed resistor

Section 6

Component layout illustrations

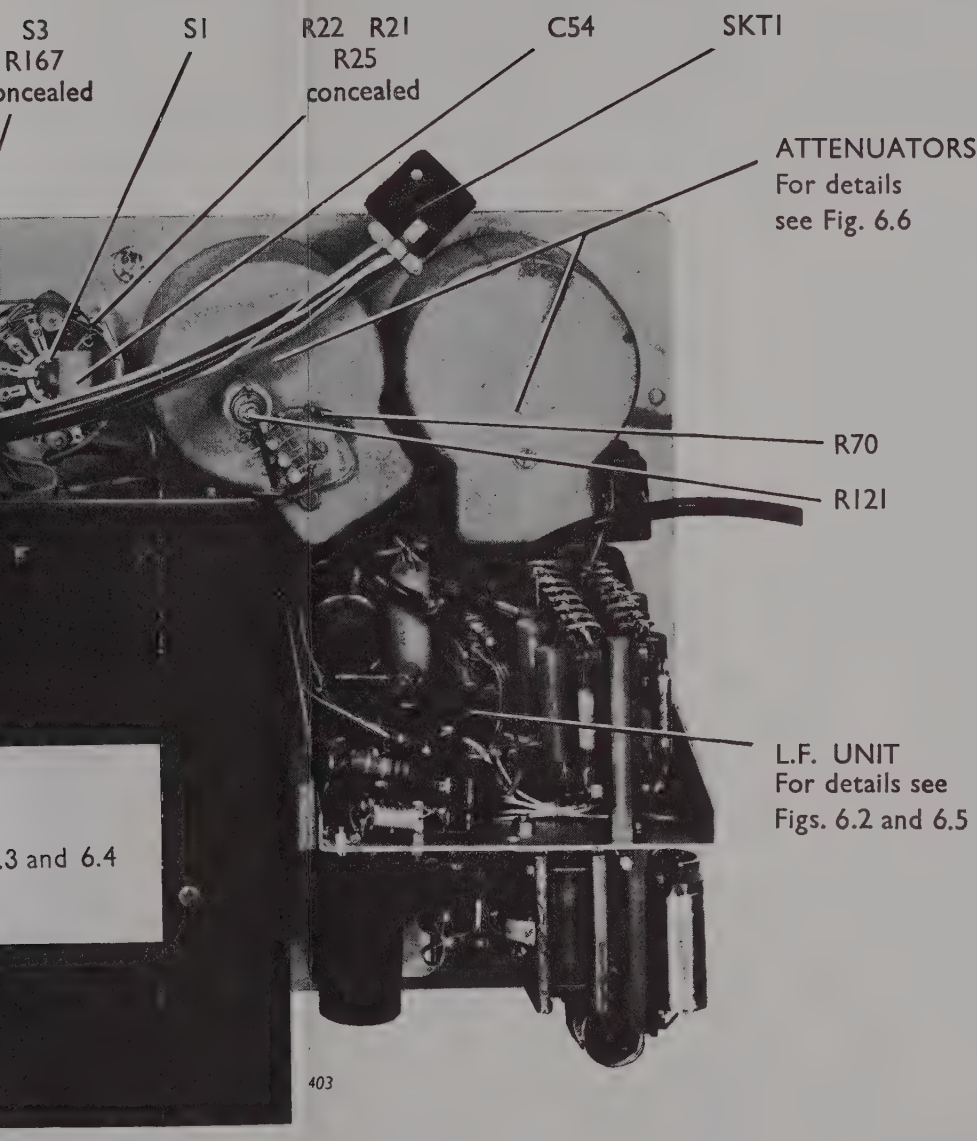
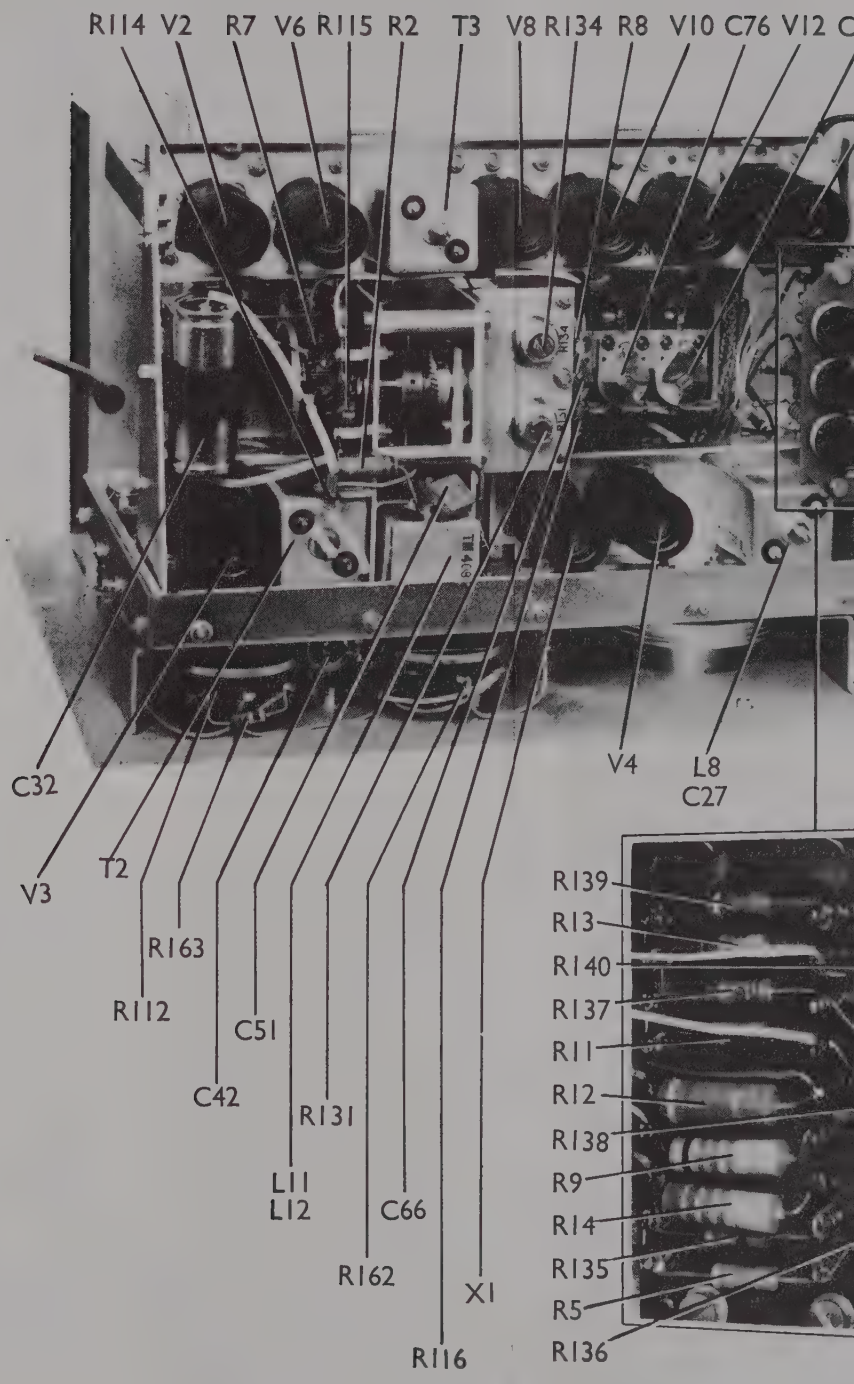


Fig. 6.1 General underside view from rear (case removed)



NOTE The sub chassis shown as supporting R131 and R134 now carries the 30 MHz crystal oscillator V16.

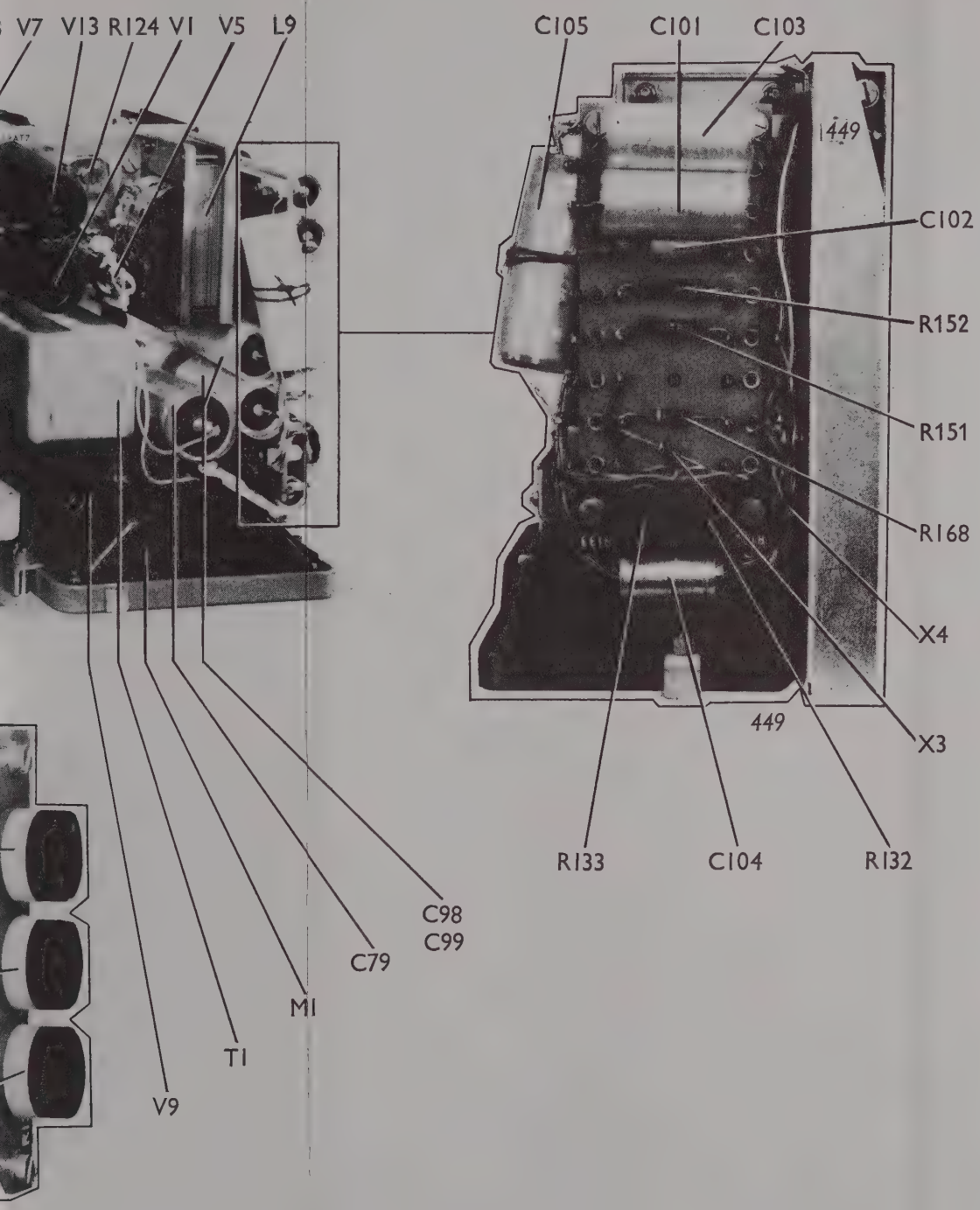
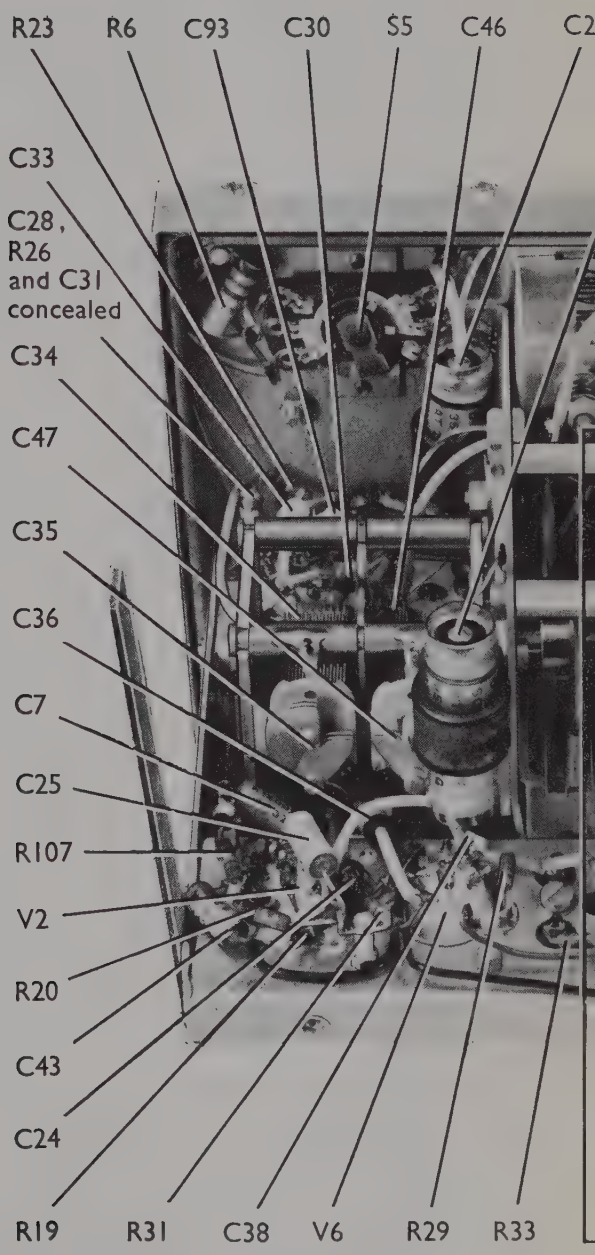


Fig. 6.2 L.f. and r.f. units. Top view with r.f. unit screening cover removed


R23
R6
C93
C30
S5
C46
C2
C33
C28,
R26
and C31
concealed
C34
C47
C35
C36
C7
C25
R107
V2
R20
C43
C24
R19
R31
C38
V6
R29
R33

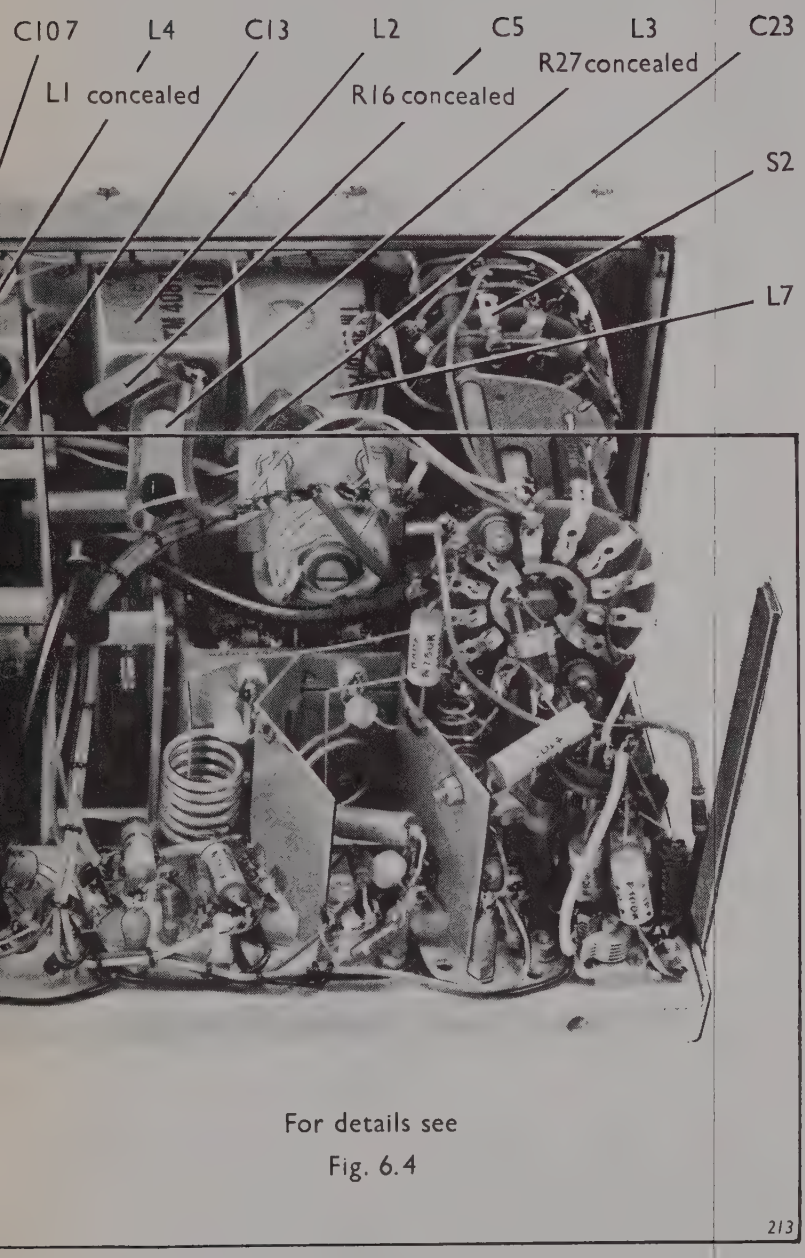
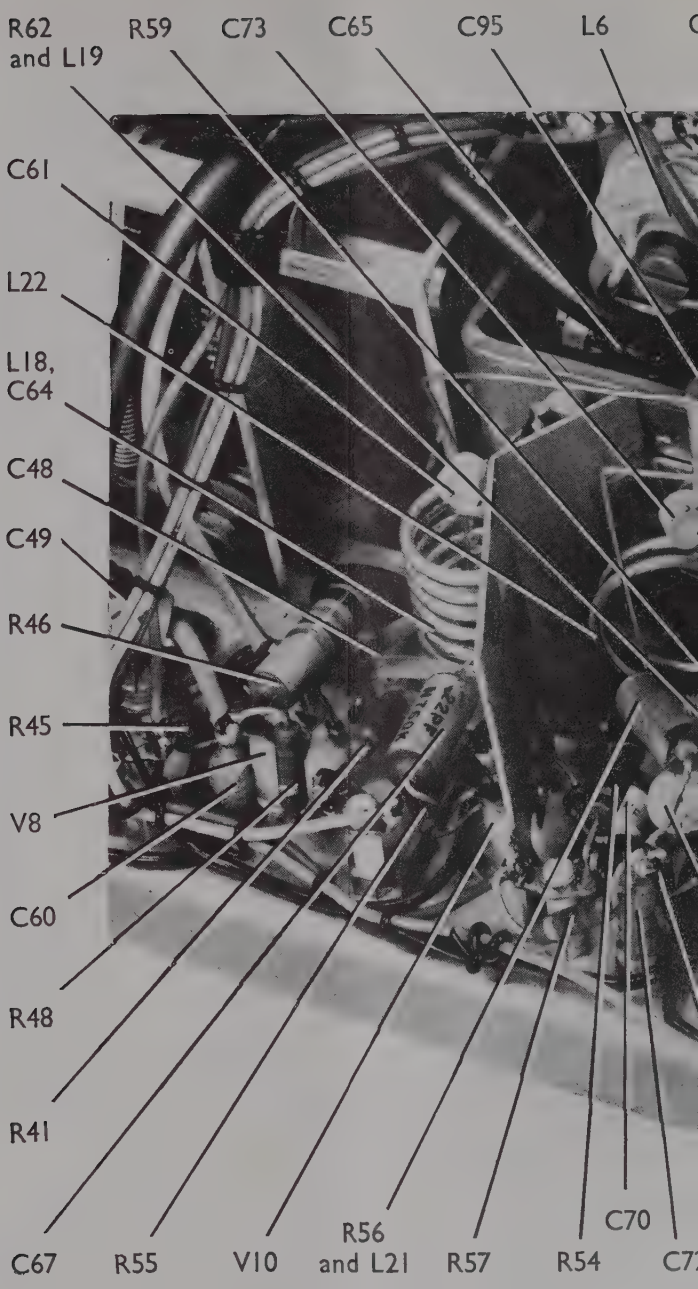


Fig. 6.3 R.f. unit, general underside view



NOTES L6 has been moved to the left.
T5 is mounted on the vertical screen by V12.
R33 is wired from the rear wafer of S2.

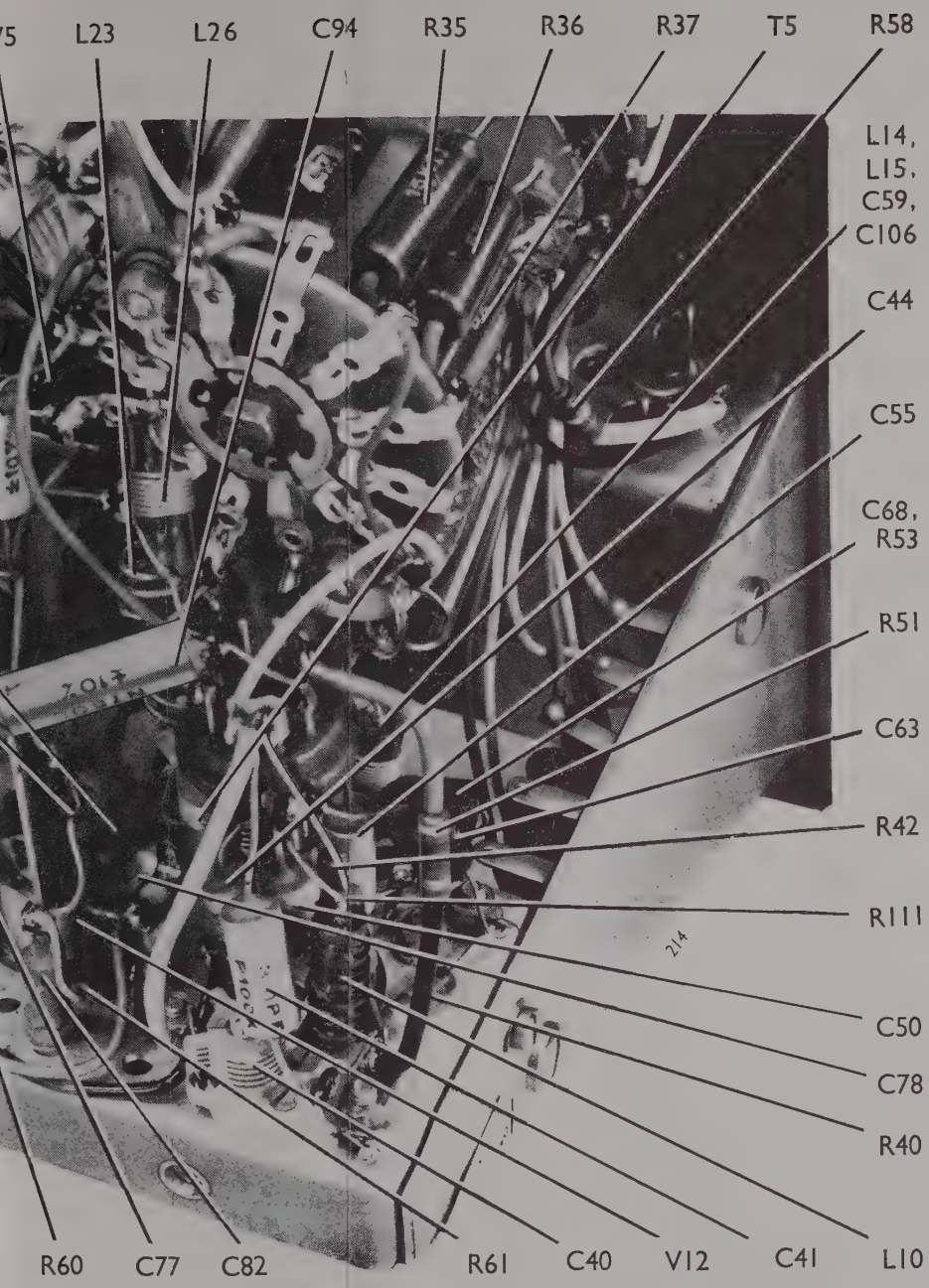
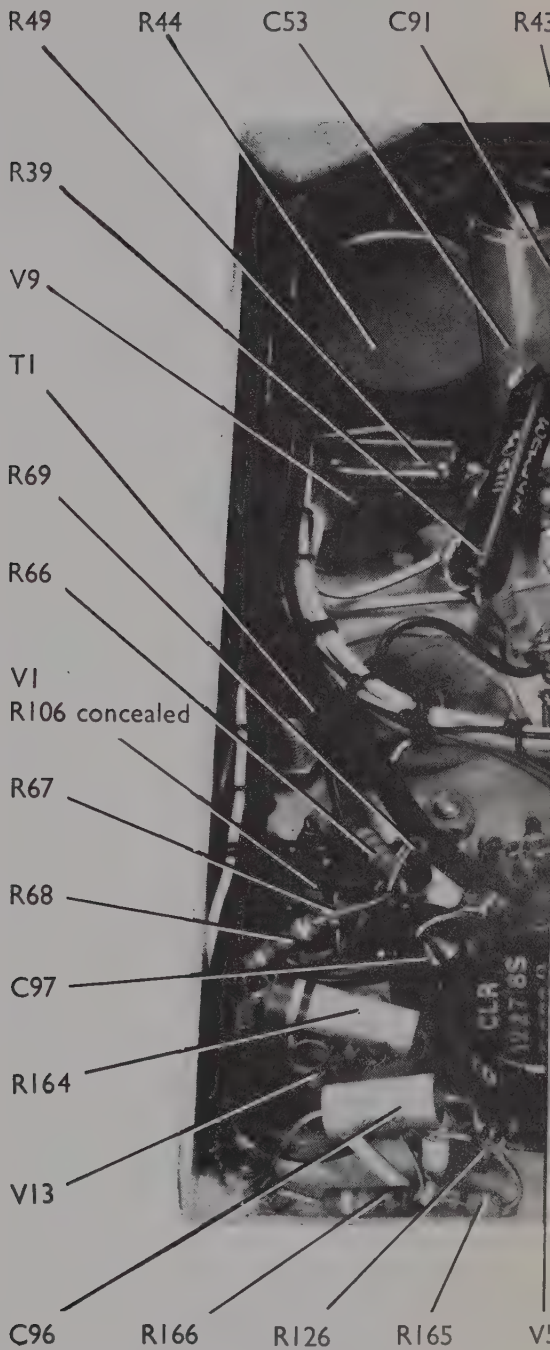


Fig. 6.4 R.f. unit, close-up of portion of underside


R49
R44
C53
C91
R43
R39
V9
T1
R69
R66
V1
R106 concealed
R67
R68
C97
R164
V13
C96
R166
R126
R165
V5

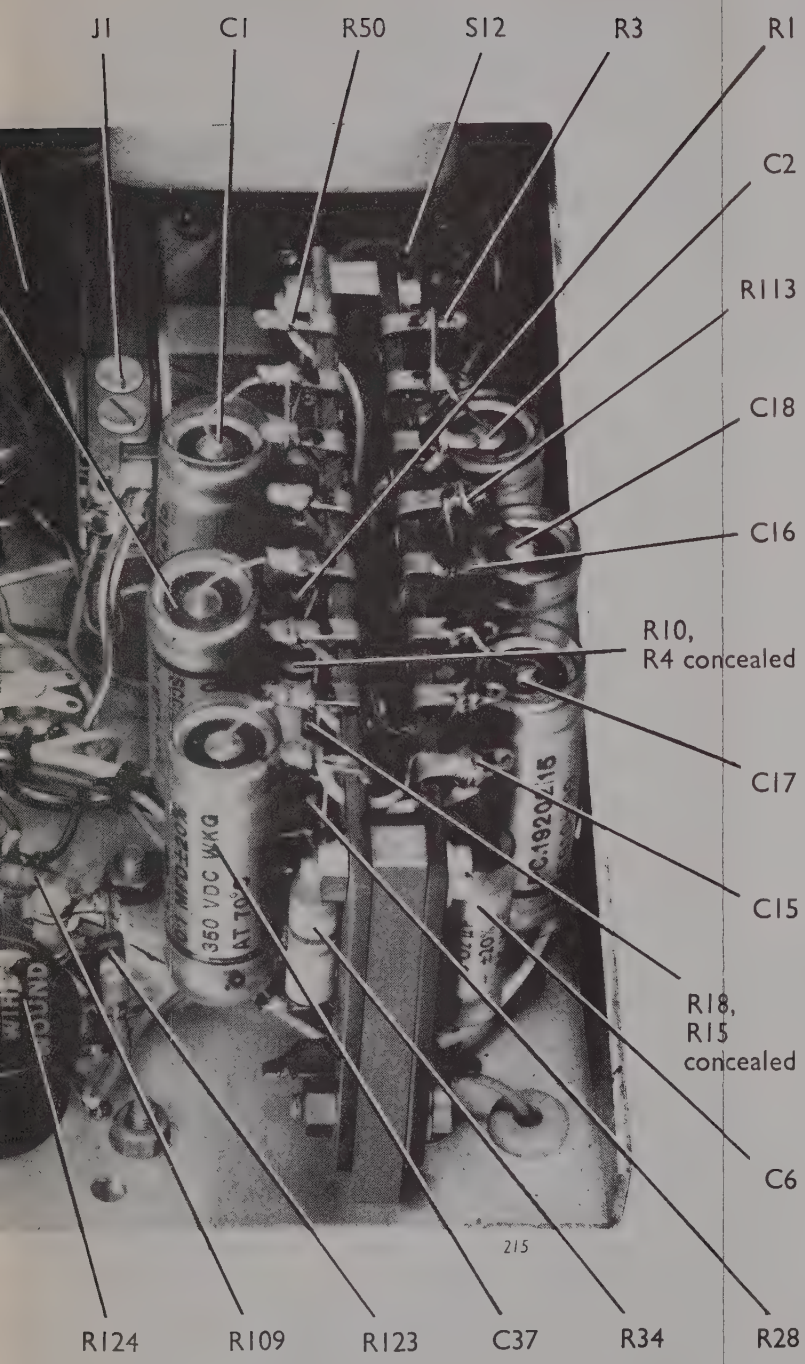
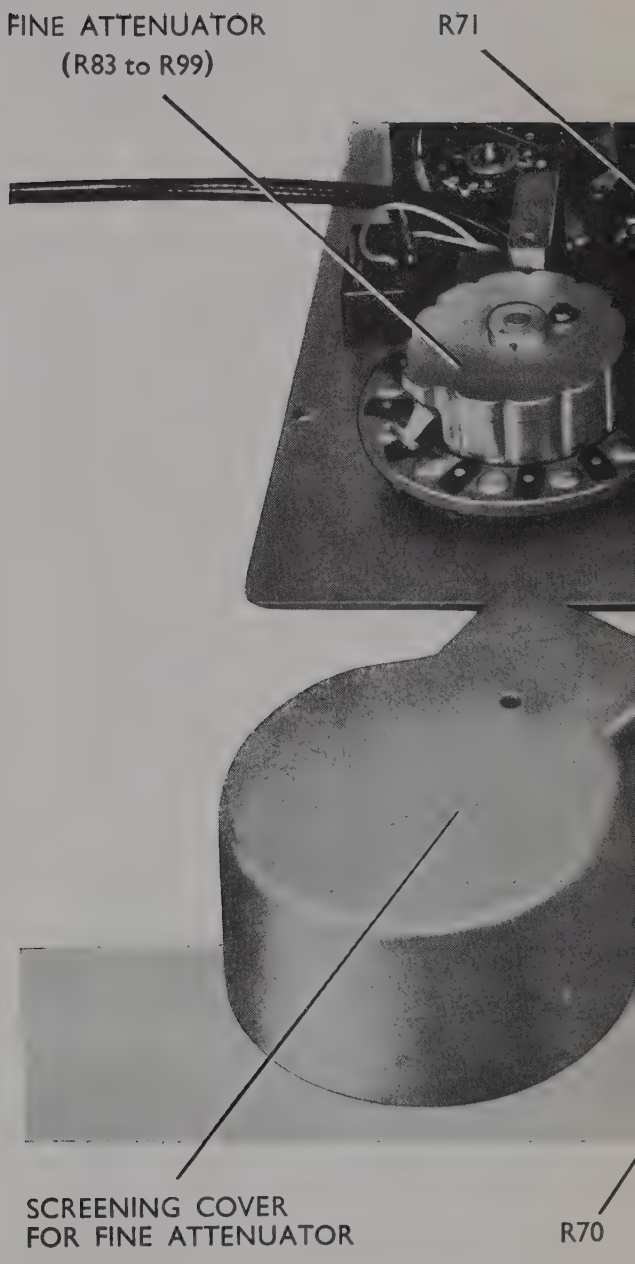


Fig. 6.5 L.f. unit, underside view


FINE ATTENUATOR
(R83 to R99)
R71
SCREENING COVER
FOR FINE ATTENUATOR
R70

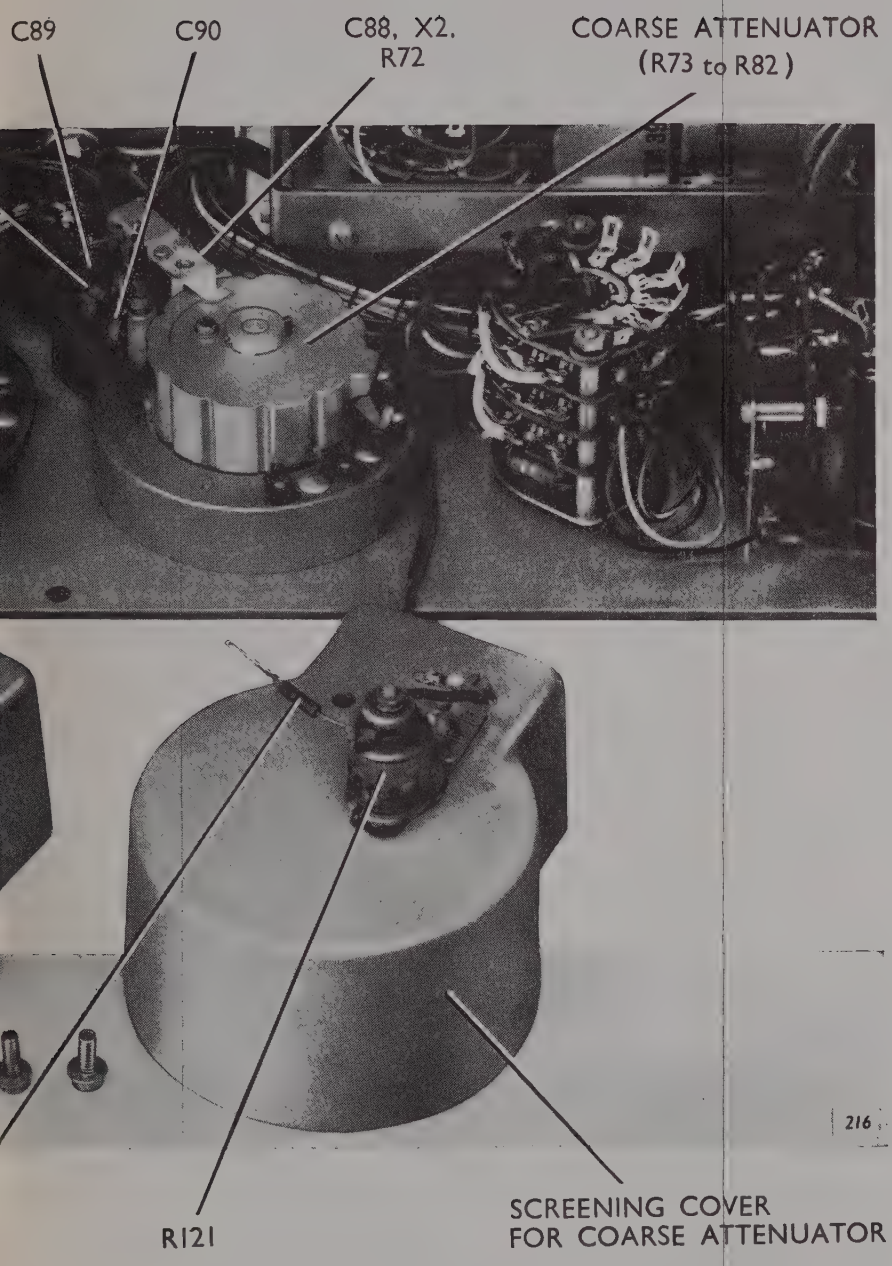
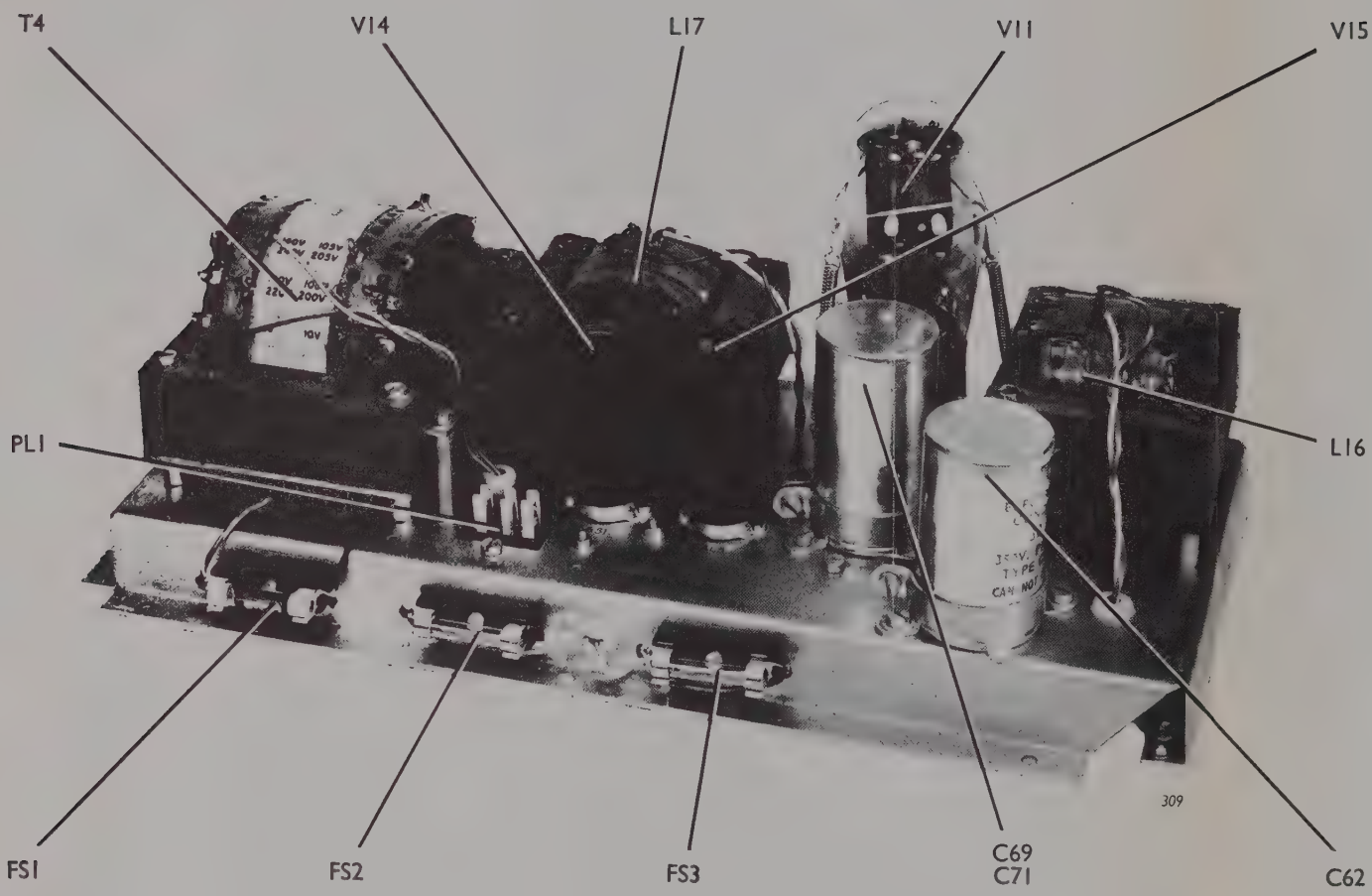


Fig. 6.6 Attenuators, covers removed



NOTE C69 and C71 are now separate components and are both mounted below the chassis.

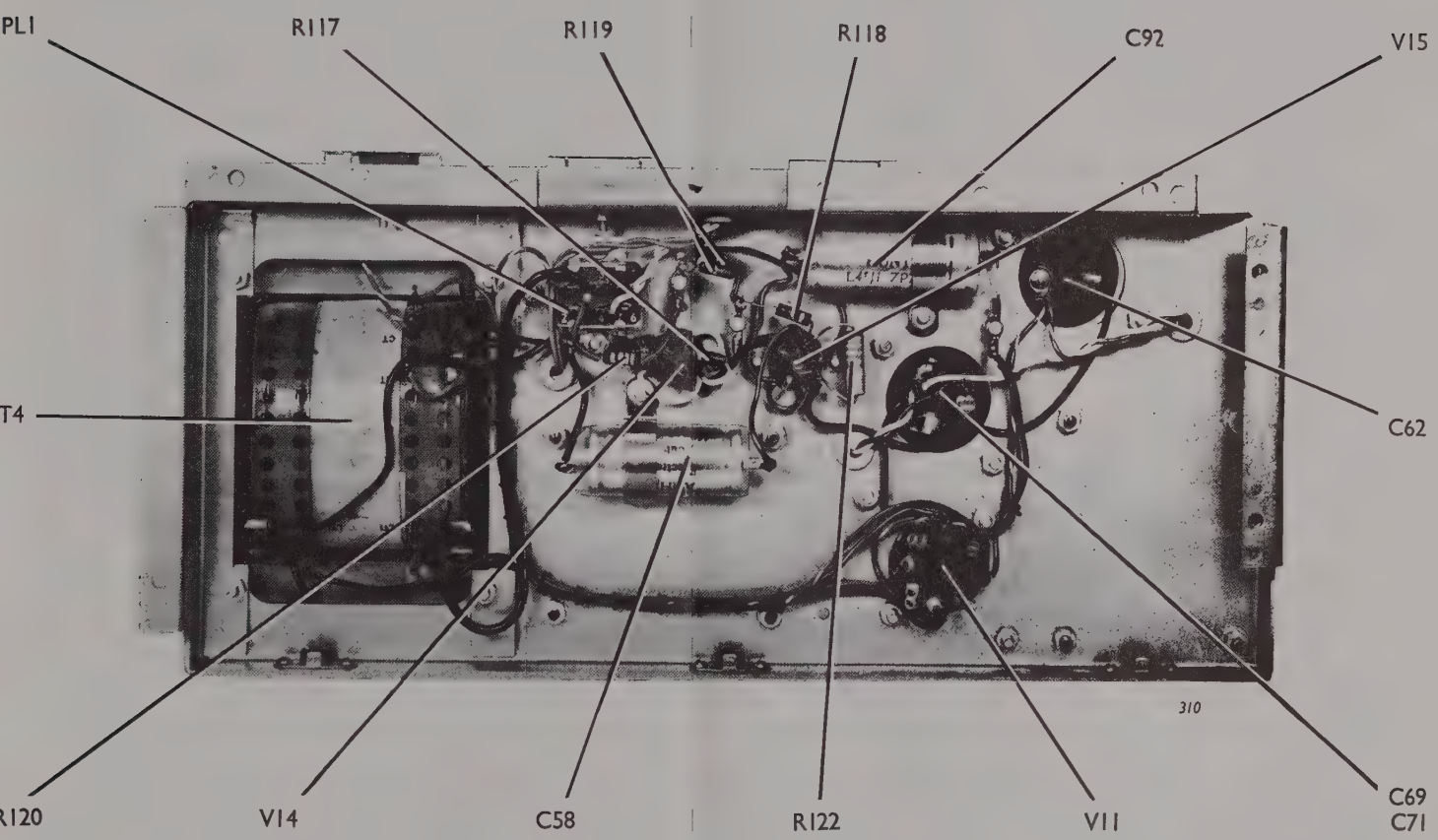


Fig. 6.7 Power unit

Section 7

Replaceable parts

INTRODUCTION

This section lists replaceable parts in alpha-numerical order of their circuit references, with miscellaneous parts at the end of the list. The following abbreviations and symbols are used:

C : capacitor
Carb : carbon
Cer : ceramic
Elec : electrolytic
FS : fuse
J : jack
L : inductor
M : meter
Met : metal
Min : minimum value
Ox : oxide
PL : plug
PLP : pilot lamp
Plas : plastic
R : resistor
S : switch
SKT : socket
T : transformer
V : valve
Var : variable
WW : wirewound
X : crystal
† : value selected during test, nominal value shown

ORDERING

Send your order for replacement parts to our Service Division at the address given on the back cover. Specify the following information for each part required:

(1) Type and serial number of your instrument.
(2) Circuit reference.
(3) Description.
(4) M.I. code number or works reference.

If a part is not listed, state its function, location and description when ordering.

Circuit reference	*Description*	*M.I. code*
C1	Paper 0·1 μF 10% 350 V	26134–455
C2	Paper 0·1 μF 10% 350 V	26134–455
C3	Mica 100 pF part of	44413–010
C4	Mica 100 pF 10% 350 V	26254–433
C5	Mica 100 pF 10% 350 V	26254–433
C6	Paper 0·02 μF 20% 350 V	12TM4800/6
C7	Cer 22 pF 5% 750 V	26324–807
C8	Mica 100 pF 10% 350 V	26254–433
C9	Mica 100 pF 20% 350 V	26252–156
C10	Mica 100 pF part of	44414–120
C12	Mica 100 pF part of	44413–010
C13	Mica 100 pF 10% 350 V	26254–433
C14	Plas 2 μF 10% 250 V	26512–288
C15	Paper 0·01 μF 25% 500 V	26383–390
C16	Paper 0·01 μF 25% 500 V	26383–390
C17	Paper 0·1 μF 10% 350 V	26134–455
C18	Paper 0·1 μF 10% 350 V	26134–455
C19	Mica 100 pF	44414–119
C20	Cer 0·1 μF +80—20% 350 V	26383–392
C21	Cer 1000 pF 20%	12TM3900/106
C22	Mica 100 pF part of	9TM3900/106
C23	Mica 100 pF 10% 350 V	20TM3900/106
C24	Paper 0·001 μF 10% 500 V	26174–125
C25	Cer 39 pF 5% 750 V	26322–828
C26	Paper 0·1 μF 10% 350 V	26134–455
C27	Paper 0·001 μF 10% 500 V	26174–125
C28	Paper 0·01 μF 10% 400 V	26174–147
C29	Mica 47 pF 20% 350 V	26254–421
C30†	Cer 10 pF 750 V	26324–709
C31	Mica 100 pF 5% 750 V	26257–162
C32	Paper 2 μF 25% 150 V	26155–581
C33	Cer 1 pF 20% 750 V	26324–020
C34	Var 14–200 pF part of	44438–008
C35	Var 3–30 pF (trimmer) part of	44438–008
C36	Cer 47 pF 2% 500 V	26324–833
C37	Paper 0·1 μF 10% 350 V	3TM4800/6
C38	Cer 100 pF 10% 500 V	26364–155
C39	Paper 0·01 μF 20% 350 V	26174–147
C40	Var 10 pF (trimmer)	26812–207
C41	Cer 10 pF 10% 750 V	26324–080
C42	Cer 0·0047 μF min 350 V	26372–615
C43	Cer 5 pF 10% 750 V	26321–060
C44	Cer 10 pF ±0·5 pF 500 V	26324–085
C45	Paper 0·5 μF 25% 150 V	26154–430
C46	Var 7–100 pF part of	44438–008
C47	Var 2–8 pF (trimmer) part of	44438–008
C48	Cer 100 pF 10% 500 V	26364–155

Circuit reference	Description	M.I. code
C49	Cer 22 pF 20% 500 V	26324–807
C50	Cer 47 pF 2% 500 V	26324–833
C51	Mica 100 pF 10% 350 V	26254–433
C52	Mica 100 pF part of	44413–010
C53	Elec 8 μF +50−20% 350 V	26417–476
C54	Paper 0·1 μF 10% 350 V	26174–173
C55	Cer 0·005 μF 20% 500 V	26367–445
C56	Mica 100 pF 10% 350 V	26254–433
C57	Mica 100 pF part of	34213–501
C58	Elec 8 μF +50−20% 450 V	26417–477
C59	Var 10 pF (trimmer)	26812–207
C60	Cer 820 pF 20% 500 V	26373–457
C61	Cer 4·7 pF ±0·25 pF 750 V	26324–017
C62	Elec 30 μF +50−20% 350 V	26427–724
C63	Paper 0·01 μF 10% 400 V	26174–147
C64	Cer 100 pF 2% 500 V	26324–897
C65	Var 7–100 pF part of	44438–011
C66	Var 2–8 pF (trimmer) part of	44438–011
C67	Cer 22 pF 20% 500 V	26324–807
C68	Paper 0·01 μF 10% 400 V	26174–147
C69	Elec 16 μF +50−20% 350 V	26427–717
C70	Cer 100 pF 10% 500 V	26364–155
C71	Elec 8 μF +50−20% 350 V	26415–320
C72	Cer 820 pF 20% 500 V	26373–457
C73	Cer 4·7 pF ±0·25 pF 750 V	26324–017
C74	Cer 100 pF 2% 500 V	26324–897
C75	Var 7–100 pF part of	44438–011
C76	Var 2–8 pF (trimmer) part of	44438–011
C77	Cer 10 pF 10% 750 V	26324–080
C78	Cer 100 pF 10% 500 V	26364–155
C79	Paper 6 μF 20% 150 V	26165–125
C80	Cer 100 pF 2% 500 V	26324–897
C81	Var 7–75 pF part of	44438–011
C82	Cer 820 pF 20% 500 V	26373–457
C83	Var 2–8 pF (trimmer) part of	44438–011
C84	Cer 100 pF 2% 750 V	26324–897
C85	Cer 100 pF 2% 750 V	26324–897
C86	Cer 100 pF 2% 750 V	26324–897
C87	Cer 100 pF 2% 750 V	26324–897
C88	Cer 820 pF 20% 500 V	26373–457
C89	Cer 820 pF 20% 500 V	26373–457
C90	Cer 820 pF 20% 500 V	26373–457
C91	Paper 0·1 μF 10% 350 V	26134–455
C92	Paper 0·25 μF 20% 350 V	26115–338
C93	Cer 15 pF ±0·25 pF 750 V	26324–712
C94	Cer 120 pF 10% 750 V	26322–905
C95	Cer 68 pF 10% 750 V	26324–868
C96†	Cer 330 pF 10% 500 V	26361–031
C97	Plas 0·047 μF 10% 400 V	26512–216
C98	Paper 2 μF 20% 150 V	26155–581
C99	Paper 2 μF 20% 150 V	26155–581
C100	Cer 0·0047 μF min 350 V	26372–615
C101	Paper 0·25 μF 20% 350 V	26155–574
C102	Paper 0·01 μF 10% 400 V	26174–147
C103	Paper 0·25 μF 20% 350 V	26155–574
C104	Paper 0·05 μF 20% 350 V	26155–559
C105	Cer 0·001 μF +40−20% 500 V	26383–242
C106	Cer 3·3 pF 10% 500 V	26321–045
C107	Paper 0·1 μF 10% 350 V	26134–455
C108	Paper 0·01 μF 20% 400 V	26174–148
C109	Paper 0·005 μF 10% 250 V	26174–141
C111†	Paper 0·05 μF 350 V	26112–458
C112†	Paper 0·002 μF 350 V	26174–129
C113†	Paper 0·005 μF 350 V	26112–419
C115	Cer 0·01 μF +80−20% 100 V	26383–055
C116	Cer 33 pF 5% 750 V	26324–822
C117	Cer 33 pF 5% 750 V	26324–822
C118	Cer 0·01 μF +80−20% 100 V	26383–055
C119	Cer 0·01 μF +80−20% 100 V	26383–055
C120	Plas 2 μF 10% 250 V	26512–288
FS1	150 mA	23411–104
FS2	2A	23411–260
FS3	2A	23411–260
J1	Jack	23421–684
J2	Jack BNC socket	23443–375
L1	H.T. filter	44413–010
L2	H.T. filter	44413–120
L3	R.F. inductor	123TM4826/15
L4	H.T. filter	44413–010
L6	Inductor (filter)	44413–120
L7	L.T. filter	44414–119
L8	R.F. inductor	44272–801
L9	Modulation inductor	44218–003
L10	Fixed osc. inductor	44226–003
L11	H.F. filter	44413–010
L12	H.F. filter	44413–010
L14	R.F. inductor	44237–001
L15	R.F. inductor	44247–401
L16	Inductor (smoothing)	44215–005
L17	Inductor (smoothing)	44215–005
L18	Inductor	44123–001

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
L19	Inductor	44123–401
L20	Inductor	44232–010
L21	Inductor	44264–409
L22	Frequency range coil	44224–006
L23	Frequency range coil	35127–505
L24	Inductor	35127–102
L25	Inductor	35127–102
L26	Inductor	44227–004
L27	Inductor	44225–018
M1	Meter 0–100 μA	44554–426
PL1	Plug 6-way	23435–216
PL2	50 Ω plug	23443–303
PLP1	Pilot lamp 6·5 V 3A	23735–440
R1	Carb 470 kΩ 10% ¼ W	24342–152
R2†	Carb 1·5 kΩ ½ W	24343–084
R3	Carb 220 kΩ 10% ½ W	24343–143
R4	Carb 270 kΩ 10% ¼ W	24342–146
R5	Met ox 47 kΩ 7% ⅞ W	24552–126
R6†	Carb 2·2 kΩ ½ W	24343–088
R7	WW 50 kΩ Var 2 W	25815–388
R8	Met ox 4·7 kΩ 7% ⅜ W	24552–100
R9†	Met ox 4·7 kΩ ⅜ W	24552–100
R10	Carb 10 kΩ 10% ½ W	24343–110
R11	Met ox 18 kΩ 7% ⅜ W	24552–116
R12†	Met ox 4·7 kΩ ½ W	24552–100
R13	Met ox 12 kΩ 7% ⅜ W	24552–112
R14†	Met ox 5·1 kΩ ⅜ W	24552–101
R15	Carb 4·7 kΩ 10% ¼ W	24342–100
R16	WW 4·7 kΩ 5% 7 W	25128–460
R17†	Carb 6·8 kΩ ¼ W	24342–306
R18	Carb 220 kΩ 10% ¼ W	24342–143
R19†	Carb 1·5 kΩ ¼ W	24134–150
R20	Carb 10 kΩ 5% ¼ W	24332–310
R21	Carb 68 kΩ 10% ¼ W	24342–131
R22	Carb 68 kΩ 10% ¼ W	24342–131
R23	Carb 56 kΩ 10% ¼ W	24342–129
R24	Carb 68 kΩ 7% ¼ W	24342–131
R25	Carb 20 kΩ Var	25612–089
R26	Carb 15 kΩ 10% ¼ W	24342–114
R27	Carb 2·7 MΩ 10% ¼ W	24342–176
R28	Carb 220 kΩ 10% ¼ W	24342–143
R29	Carb 6·8 kΩ 10% ¼ W	24342–106
R30	Carb 6·8 kΩ 10% ¼ W	24342–106
R31	Carb 270 kΩ 10% ¼ W	24342–146
R32	Carb 150 Ω 10% ¼ W	24342–054
R33	Carb 2·2 kΩ 10% ¼ W	24342–088
R34	Carb 390 Ω 5% ½ W	24332–065
R35	WW 15 kΩ 5% 7 W	25128–474
R36	WW 7·5 kΩ 5% 7 W	25128–467
R37	WW 5 kΩ 5% 7 W	25128–461
R38	WW 10 Ω 5% 1½ W	25123–020
R39†	WW 47 kΩ 4½ W	25126–626
R40	Carb 15 kΩ 10% ¼ W	24342–114
R41	Carb 6·8 kΩ 10% ¼ W	24342–106
R42	Carb 2·2 kΩ 10% ¼ W	24342–088
R43	Carb 10 kΩ 10% 1 W	24345–510
R44	Carb Var 200 kΩ +200 kΩ	25673–209
R45	Carb 100 kΩ 10% ¼ W	24342–135
R46	Carb 6·8 kΩ 10% ½ W	24343–106
R47	Met ox 36 kΩ 7% ¼ W	24552–123
R48	Carb 2·2 kΩ 10% ¼ W	24342–088
R49	WW 4 kΩ 5% 7 W	25128–457
R50†	Carb 100 kΩ ½ W	24343–135
R51	Carb 4·7 kΩ 10% ¼ W	24342–100
R53	Carb 270 Ω 10% ¼ W	24342–061
R54	Carb 6·8 kΩ 10% ¼ W	24342–106
R55	Carb 68 kΩ 10% ¼ W	24342–131
R56	Carb 47 kΩ 10% ½ W part of	44264–409
R57	Carb 2·2 kΩ 10% ¼ W	24342–088
R58	Carb 100 kΩ 10% ¼ W	24342–135
R59	Carb 6·8 kΩ 10% ¼ W	24342–106
R60	Carb 100 kΩ 10% ¼ W	24342–135
R61	Carb 2·2 kΩ 10% ¼ W	24342–088
R62	Carb 33 kΩ 10% ½ W	24343–122
R63	Met ox 27 kΩ 7% ¼ W	24552–120
R64	Met ox 82 kΩ 7% ¼ W	24552–133
R65	Met ox 12 kΩ 7% ¼ W	24552–112
R66	Carb 33 kΩ 10% ¼ W	24342–122
R67	Carb 470 Ω 10% ¼ W	24342–069
R68	Carb 4·7 kΩ 10% ¼ W	24342–100
R69	Carb 1 MΩ 10% ¼ W	24342–166
R70†	Carb 2·7 kΩ ¼ W	24342–092
R71	Carb 1 kΩ 10% ¼ W	24342–080
R72	Carb 1 kΩ 10% ¼ W	24342–080
R73	Carb 82·5 Ω 1% ¼ W	24132–043
R74	Carb 742 Ω 1% ¼ W	24133–093
R75	Carb 742 Ω 1% ¼ W	24133–093
R76	Carb 742 Ω 1% ¼ W	24133–093
R77	Carb 742 Ω 1% ¼ W	24133–093
R78	Carb 220 Ω 1% ¼ W	24133–040
R79	Carb 91·6 Ω 1% ¼ W	24132–053

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
R80	Carb 91·6 Ω 1% ¼ W	24132–053
R81	Carb 91·6 Ω 1% ¼ W	24132–053
R82	Carb 82·5 Ω 1% ¼ W	24132–043
R83	Carb 17·9 Ω 1% ¼ W	24132–179
R84	Carb 17·9 Ω 1% ¼ W	24132–179
R85	Carb 17·9 Ω 1% ¼ W	24132–179
R86	Carb 17·9 Ω 1% ¼ W	24132–179
R87	Carb 17·9 Ω 1% ¼ W	24132–179
R88	Carb 17·9 Ω 1% ¼ W	24132–179
R89	Carb 17·9 Ω 1% ¼ W	24132–179
R90	Carb 17·9 Ω 1% ¼ W	24132–179
R91	Carb 17·9 Ω 1% ¼ W	24132–179
R92	Carb 17·9 kΩ 1% ¼ W	24132–179
R93	Carb 61·2 Ω 1% ¼ W	24132–612
R94	Carb 332 Ω 1% ¼ W	24133–068
R95	Carb 167 Ω 1% ¼ W	24133–025
R96	Carb 167 Ω 1% ¼ W	24133–025
R97	Carb 167 Ω 1% ¼ W	24133–025
R98	Carb 167 Ω 1% ¼ W	24133–025
R99	Carb 37·5 Ω 1% ¼ W	24132–017
R100	Carb 90 Ω 1% ¼ W	24132–900
R101	Carb 90 Ω 1% ¼ W	24132–900
R102	Carb 360 Ω 1% ¼ W	24133–360
R103	Carb 37·5 Ω 1% ¼ W	24132–017
R104	Carb 75 Ω 1% ¼ W	24132–039
R105	Carb 14·5 Ω 5% ¼ W	24232–804
R106	Carb 560 Ω 10% ¼ W	24342–072
R107	Carb 22 kΩ 10% ¼ W	24342–118
R109	Carb 2·2 kΩ 10% ¼ W	24342–088
R110	Carb 100 Ω 10% ¼ W	24342–050
R112	WW 20 kΩ Var 2 W	25816–365
R113	Carb 68 kΩ 10% ½ W	24343–131
R114†	Carb 100 kΩ ½ W	24343–135
R115	Carb 1 kΩ 10% ¼ W	24342–080
R116	Met ox 180 Ω 7% ⅜ W	24552–056
R117	Carb 2·2 kΩ 10% ¼ W	24342–088
R118	Carb 22 kΩ 10% ¼ W	24343–118
R119†	Carb 68 kΩ ¼ W	24342–131
R120	Carb 33 kΩ 10% ¼ W	24342–122
R121	WW 950 Ω 10%	44364–306
R122	Carb 35 kΩ 10% ½ W	24343–122
R123	Carb 68 kΩ 10% ¼ W	24342–131
R124	WW 5 kΩ Var	25813–342
R125	Carb 2·2 kΩ 10% ¼ W	24342–088
R126	Carb 1 MΩ 10% ¼ W	24342–166
R127	Met ox 33 kΩ 7% ¼ W	24552–122
R128	Carb 10 kΩ Var ¼ W	25611–126
R129	Carb 47 kΩ Var ¼ W	25611–134
R130	Carb 10 kΩ Var ¼ W	25611–126
R131	Carb 1 kΩ Var 1 W	25886–614
R132	Carb 100 kΩ Var ¼ W	25611–138
R133	Carb 470 kΩ Var ¼ W	25611–146
R134	WW 10 kΩ Var 1 W	25886–623
R135	Met ox 47 kΩ 7% ⅜ W	24552–126
R136	Carb 47 kΩ Var ¼ W	25611–134
R137	Met ox 22 kΩ 7% ⅜ W	24552–118
R138	Carb 47 kΩ Var ¼ W	25611–134
R139	Met ox 3·9 kΩ 7% ⅜ W	24552–096
R140	Carb 10 kΩ Var ¼ W	25611–126
R143	Carb 10 Ω 10% ¼ W	24342–020
R144	Carb 120 Ω 10% ¼ W	24342–052
R145	Carb 10 Ω 10% ¼ W	24342–020
R146	Carb 4·7 kΩ 10% ¼ W	24342–100
R147	Carb 100 kΩ 10% ¼ W	24342–135
R148	Carb 10 kΩ 10% ¼ W	24342–110
R149	Carb 10 kΩ 10% ¼ W	24342–110
R150	Carb 6·8 kΩ 10% ¼ W	24342–106
R151	Met ox 100 kΩ 7% ⅜ W	24552–135
R152	Met ox 270 k Ω7% ⅜ W	24552–146
R154	Carb 10 kΩ 1% ¼ W	24135–100
R155	Carb 10 kΩ 1% ¼ W	24135–100
R156	Carb 10 kΩ 1% ¼ W	24135–100
R157	Carb 10 kΩ 1% ¼ W	24135–100
R158	Carb 10 kΩ 1% ¼ W	24135–100
R159	Carb 10 kΩ 1% ¼ W	24135–100
R160	Carb 10 kΩ 1% ¼ W	24135–100
R161	Carb 10 kΩ ¼ W	24135–100
R162	WW 25 kΩ Var 3 W	44371–516
R163†	Carb 82 kΩ ¼ W	24342–133
R164	Carb 120 kΩ 10% ½ W	24343–137
R165	Carb 470 Ω 10% ¼ W	24342–069
R166	Carb 10 kΩ 1% ¼ W	24135–100
R167	Carb 10 kΩ ¼ W	24342–110
R168	Carb 1 MΩ 10% ½ W	24342–166
R169	Carb 470 kΩ 10% ¼ W	24342–552
R170	Carb 3·3 MΩ 10% ¼ W	24342–178
R171	Carb 33 kΩ 10% 1 W	24345–522
R172	Carb 470 Ω 10% ¼ W	24342–069
S1	MOD SELECTOR	44324–418
S2	RANGE MHZ	44324–506
S3	METER READS	44322–112
S4	SUPPLY ON/OFF	44334–003
S5	DEVIATION	23462–107
S6	DEVIATION RANGE	23462–107
S8	Microswitch	23483–145
S10	INC FREQ	44324–103
S11	CARRIER ON/OFF	44334–003
S12	SET MOD FREQ	44322–105

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
SKT1	6-way	23435–260
SKT2	75 Ω socket	23443–423
SKT3	52 Ω socket	23443–423
T1	L.F. Oscillator	44215–007
T2	Master osc. transformer	44252–207
T3	Multiplier R.F. Transformer	TM3900/52
T4	Mains transformer	43463–006
T5	I.F. output transformer	43561–009
V1	6AK6	28152–232
V2	6AK5	28152–482
V3	EF86	28154–207
V4	6AK5	28152–482
V5	6AU6	28152–512
V6	6AK5	28152–482
V7	12AT7	28124–602
V8	6AK5	28152–482
V9	0A2	28213–352
V10	6AK5	28152–482
V11	5Z4G	28113–622
V12	6AK5	28152–482
V13	12AT7	28124–602
V14	5651	28216–234
V15	6AL5	28112–727
V16	6AK5	28152–482
X1	Master crystal	28311–165
X2	Crystal rectifier	28346–121
X3	OA81	28323–307
X4	OA81	28323–307
X5	30 MHz	28311–850

KNOBS, DRIVES AND DIALS

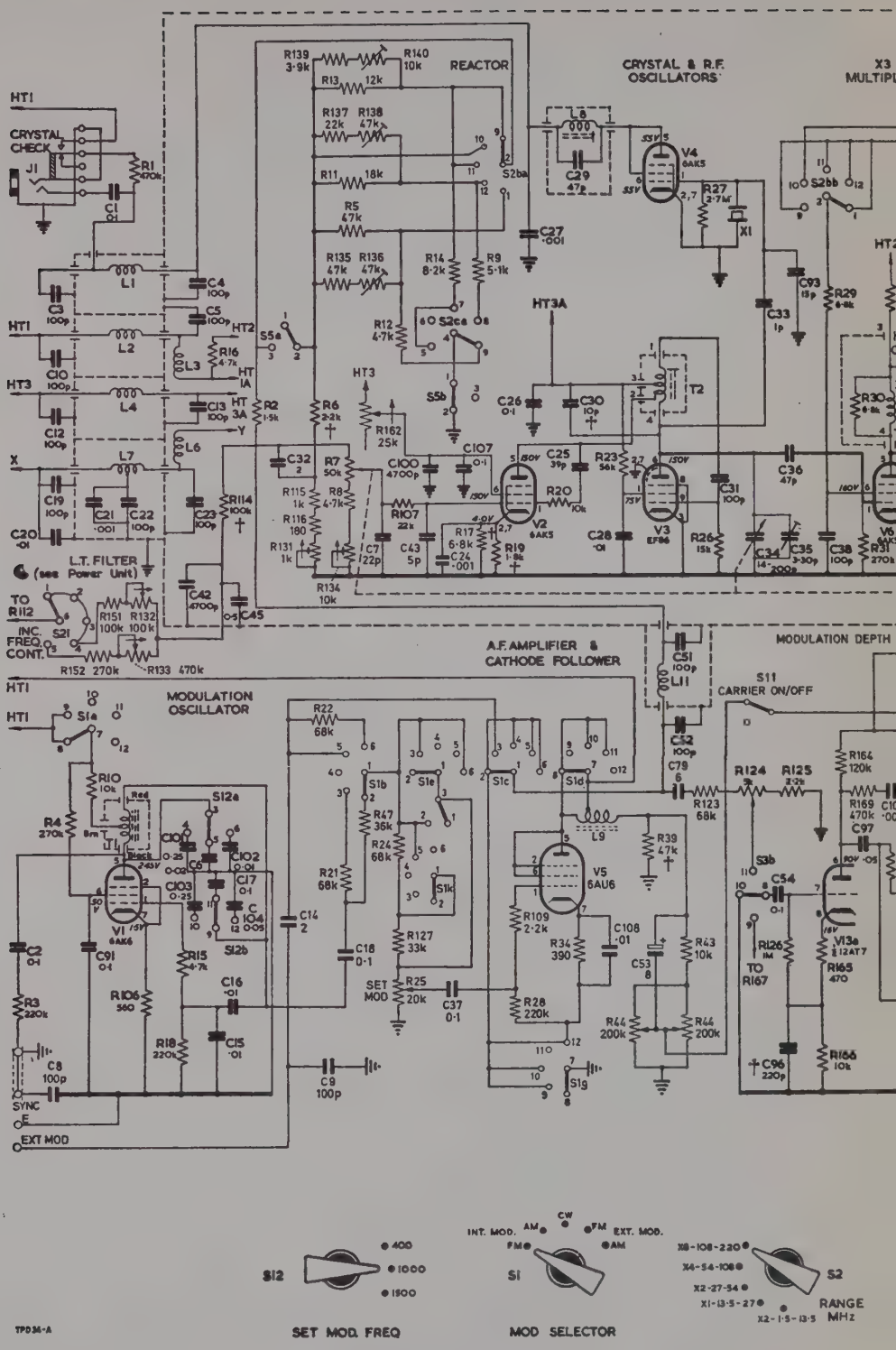
Knobs, for TUNE and INC. FREQ. controls	TB29569
COARSE TUNE control dial	TB4691A/18
FINE TUNE control dial	TB28875
COARSE INC. FREQ. control dial	TB26194
FINE INC. FREQ. control dial	TD27529/5
FREQUENCY DIAL. Pre-calibrated	TB23189
Dial escutcheon mounting ring	TD20670/2
Dial escutcheon (chromium plated) with rubber tubing	TD20670/1

Circuit reference	Description	M.I. code
Gasket, to fit over mounting ring		8-TM4357/2
Window, including movable cursor assembly, to fit in dial escutcheon		TC20735/2
Nylon drive cord		12TM4826/2
Knob, for SET MOD. FREQ. switch, S12		TB25460
Knob, for MOD. SELECTOR switch, S1		TB25460/2
Knob, for RANGE MHz switch, S2		TB25460/2
Knob, for DEVIATION–NORMAL/HIGH switch, S5		TB25460/2
Knob, for DEVIATION RANGE switch, S6		TB25460/2
Knob, for OUTPUT VOLTAGE attenuator		TB17848/3
Knob, for MULTIPLY BY attenuator		TB17848/3
Knob, for SET CARRIER control, R44		TB23920/1
Knob, for SET MOD. control, R25		TB23920/1

MISCELLANEOUS

Cover plate, for R.F. output cable exit, in right-hand handle recess	TA19721
Grommet, to fit in cover plate	TA6515/1
Cable saddle	29-TF995B/5
Front panel	TD22009/5
Set of eight screws, complete with black fibre washers for fixing front panel to case	30-TF995B/5 TB6775/183
Terminal, EXT. MOD.	TB24330/5
Terminal, SYNC.	TB24330/5
Terminal, EARTH	TB24330/5
Case assembly, complete with handles and feet	TM4310 TC17659 TA11420
Handle escutcheon	TC17659
Case foot	TA11420
20 dB step attenuator assembly	TM 4297A
2 dB step attenuator assembly	TM4298
20 dB attenuator pad	TM5552
52 and 75 Ω Terminating Unit	TM5551
R.F. unit screening cover	26TM4826/5
Contact spring for earthing R.F. unit screening cover	TC20321/3E
Set of three hexagonal wrenches for socket set screws, sizes 2, 4 and 6BA; complete in linen bag	104-TF995B/2
Instruction Manual	EB995B/5

For symbols and abbreviations see introduction to this section



TP034-A

NOTES

1. **COMPONENT VALUES**
   Resistors: No suffix = ohms. k = kilohms. M = megohms.
   Capacitors: No suffix = microfarads. p = picofarads.
   † Value selected during factory testing; nominal value shown
2. **VOLTAGES** (*in italics*)
   Measured relative to earth unless otherwise stated.

Circuit diagrams

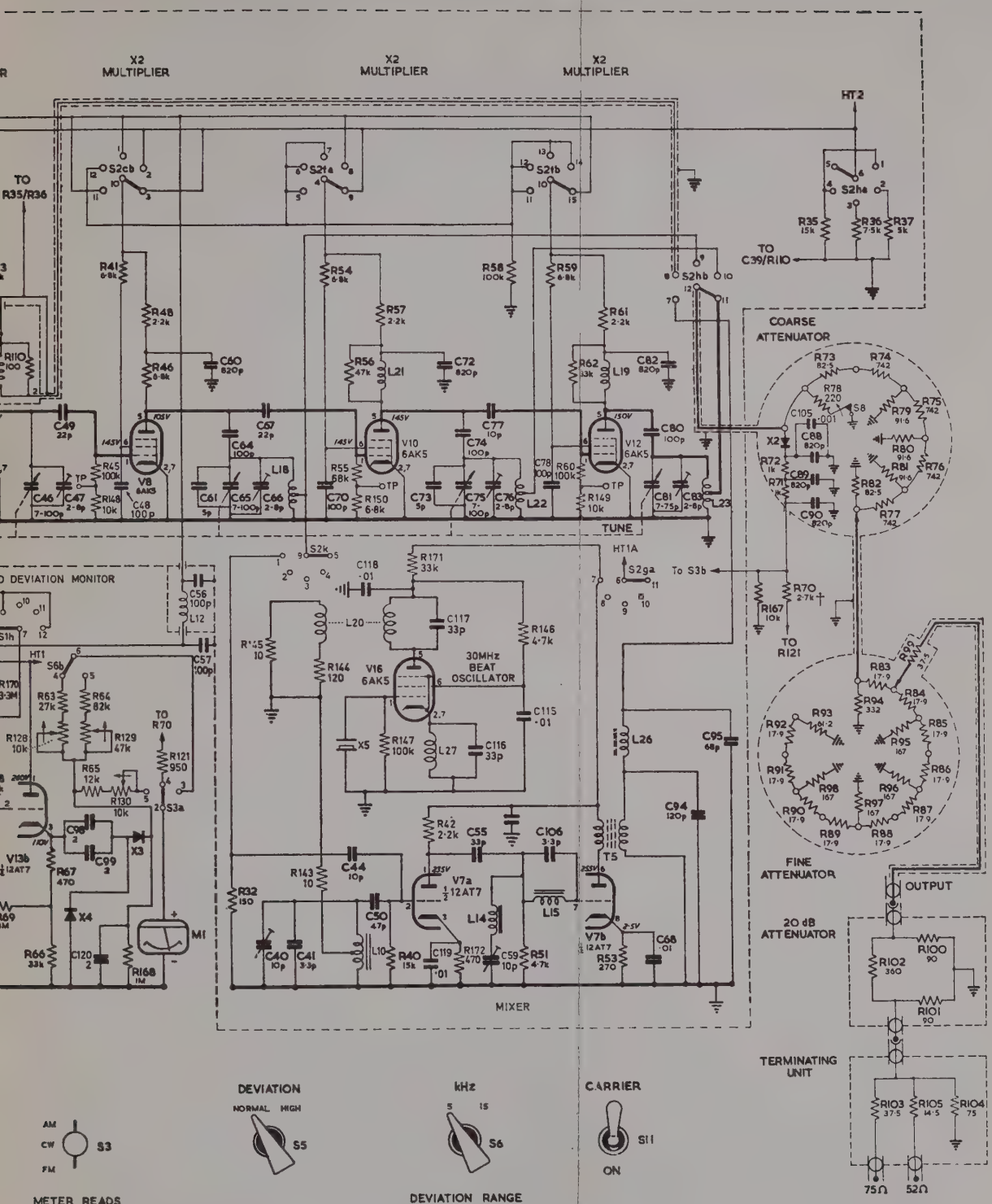
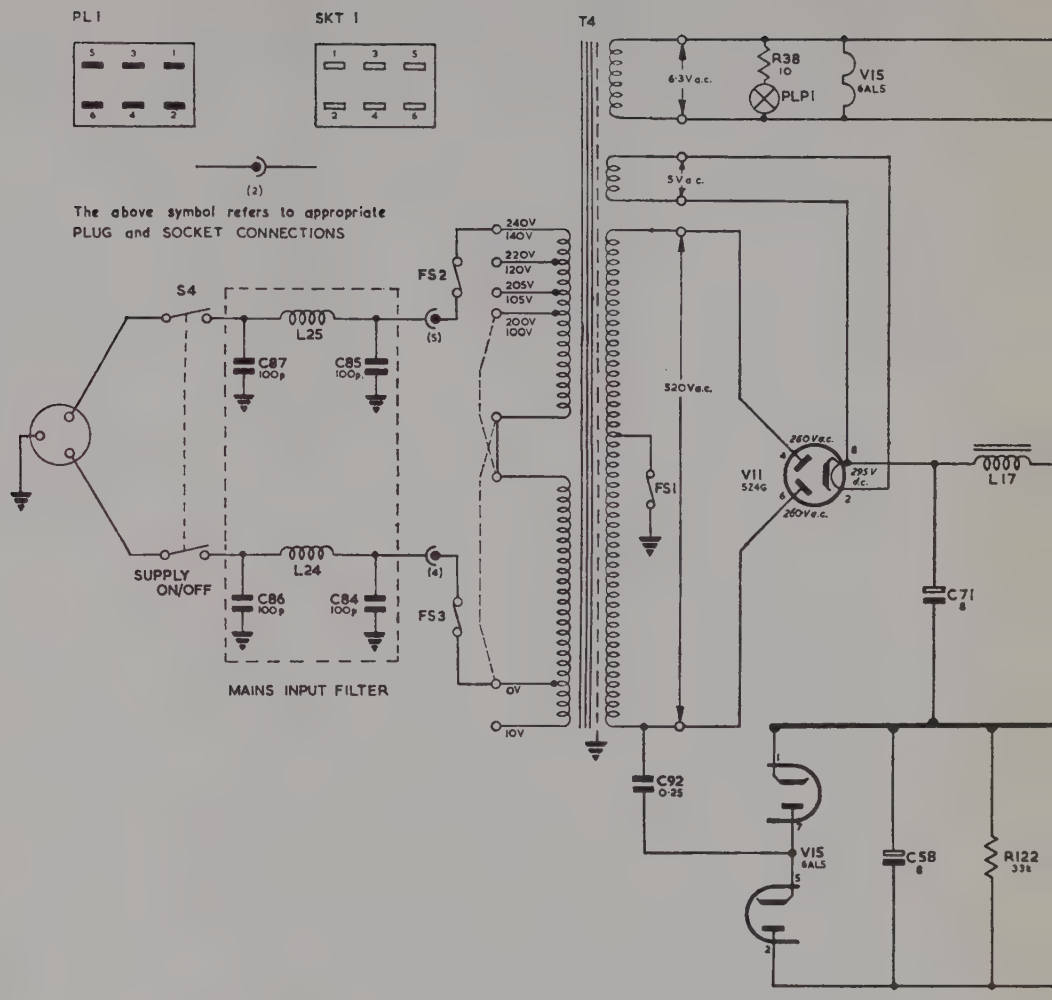


Fig. 8.1 R.F. and L.F. Units



NOTES

1. **COMPONENT VALUES**
   Resistors: No suffix = ohms. k = kilohms. M = megohms.
   Capacitors: No suffix = microfarads. p = picofarads.
   † Value selected during factory testing; nominal value shown.
2. **VOLTAGES**
   Measured relative to earth unless otherwise stated.
3. **MAINS TRANSFORMER T4 PRIMARY**
   Solid link for 200–250V working.
   Dotted links for 100–150V working.

Ex TD47955/5 Is. 1.

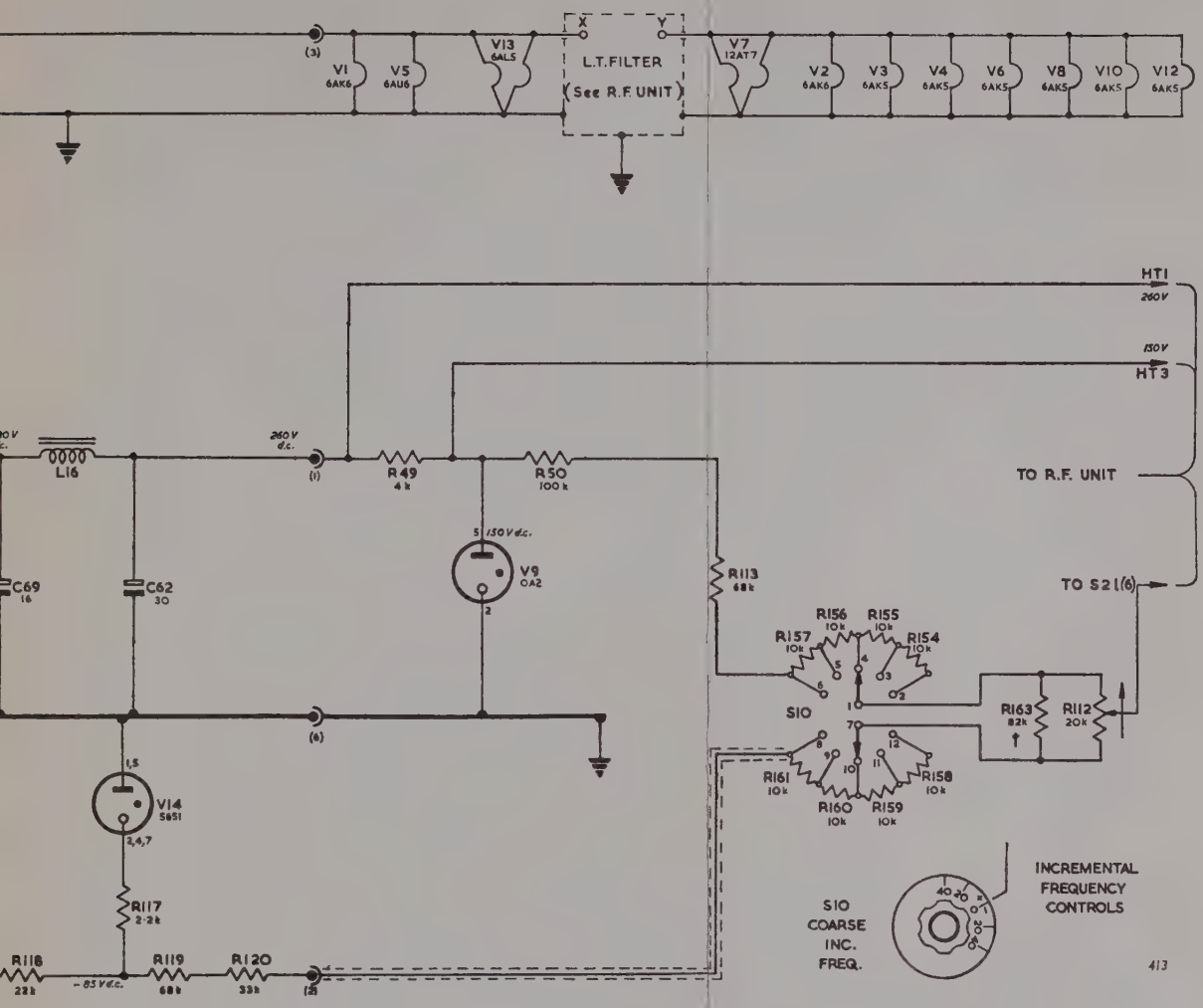


Fig. 8.2 Power Unit

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	**0**	1·0	1·0
·9886	·9772	**·1**	1·012	1·023
·9772	·9550	**·2**	1·023	1·047
·9661	·9333	**·3**	1·035	1·072
·9550	·9120	**·4**	1·047	1·096
·9441	·8913	**·5**	1·059	1·122
·9333	·8710	**·6**	1·072	1·148
·9226	·8511	**·7**	1·084	1·175
·9120	·8318	**·8**	1·096	1·202
·9016	·8128	**·9**	1·109	1·230
·8913	·7943	**1·0**	1·122	1·259
·8710	·7586	**1·2**	1·148	1·318
·8511	·7244	**1·4**	1·175	1·380
·8318	·6918	**1·6**	1·202	1·445
·8128	·6607	**1·8**	1·230	1·514
·7943	·6310	**2·0**	1·259	1·585
·7762	·6026	**2·2**	1·288	1·660
·7586	·5754	**2·4**	1·318	1·738
·7413	·5495	**2·6**	1·349	1·820
·7244	·5248	**2·8**	1·380	1·905
·7079	·5012	**3·0**	1·413	1·995
·6683	·4467	**3·5**	1·496	2·239
·6310	·3981	**4·0**	1·585	2·512
·5957	·3548	**4·5**	1·679	2·818
·5623	·3162	**5·0**	1·778	3·162
·5309	·2818	**5·5**	1·884	3·548
·5012	·2512	**6**	1·995	3·981
·4467	·1995	**7**	2·239	5·012
·3981	·1585	**8**	2·512	6·310
·3548	·1259	**9**	2·818	7·943
·3162	·1000	**10**	3·162	10·000
·2818	·07943	**11**	3·548	12·59
·2512	·06310	**12**	3·981	15·85
·2239	·05012	**13**	4·467	19·95
·1995	·03981	**14**	5·012	25·12
·1778	·03162	**15**	5·623	31·62

Continued

DECIBEL CONVERSION TABLE (continued)

Ratio Down			Ratio Up	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	$6{\cdot}310 \times 10^{-3}$	**22**	12·59	158·5
·06310	$3{\cdot}981 \times 10^{-3}$	**24**	15·85	251·2
·05012	$2{\cdot}512 \times 10^{-3}$	**26**	19·95	398·1
·03981	$1{\cdot}585 \times 10^{-3}$	**28**	25·12	631·0
·03162	$1{\cdot}000 \times 10^{-3}$	**30**	31·62	1,000
·02512	$6{\cdot}310 \times 10^{-4}$	**32**	39·81	$1{\cdot}585 \times 10^{3}$
·01995	$3{\cdot}981 \times 10^{-4}$	**34**	50·12	$2{\cdot}512 \times 10^{3}$
·01585	$2{\cdot}512 \times 10^{-4}$	**36**	63·10	$3{\cdot}981 \times 10^{3}$
·01259	$1{\cdot}585 \times 10^{-4}$	**38**	79·43	$6{\cdot}310 \times 10^{3}$
·01000	$1{\cdot}000 \times 10^{-4}$	**40**	100·00	$1{\cdot}000 \times 10^{4}$
$7{\cdot}943 \times 10^{-3}$	$6{\cdot}310 \times 10^{-5}$	**42**	125·9	$1{\cdot}585 \times 10^{4}$
$6{\cdot}310 \times 10^{-3}$	$3{\cdot}981 \times 10^{-5}$	**44**	158·5	$2{\cdot}512 \times 10^{4}$
$5{\cdot}012 \times 10^{-3}$	$2{\cdot}512 \times 10^{-5}$	**46**	199·5	$3{\cdot}981 \times 10^{4}$
$3{\cdot}981 \times 10^{-3}$	$1{\cdot}585 \times 10^{-5}$	**48**	251·2	$6{\cdot}310 \times 10^{4}$
$3{\cdot}162 \times 10^{-3}$	$1{\cdot}000 \times 10^{-5}$	**50**	316·2	$1{\cdot}000 \times 10^{5}$
$2{\cdot}512 \times 10^{-3}$	$6{\cdot}310 \times 10^{-6}$	**52**	398·1	$1{\cdot}585 \times 10^{5}$
$1{\cdot}995 \times 10^{-3}$	$3{\cdot}981 \times 10^{-6}$	**54**	501·2	$2{\cdot}512 \times 10^{5}$
$1{\cdot}585 \times 10^{-3}$	$2{\cdot}512 \times 10^{-6}$	**56**	631·0	$3{\cdot}981 \times 10^{5}$
$1{\cdot}259 \times 10^{-3}$	$1{\cdot}585 \times 10^{-6}$	**58**	794·3	$6{\cdot}310 \times 10^{5}$
$1{\cdot}000 \times 10^{-3}$	$1{\cdot}000 \times 10^{-6}$	**60**	1,000	$1{\cdot}000 \times 10^{6}$
$5{\cdot}623 \times 10^{-4}$	$3{\cdot}162 \times 10^{-7}$	**65**	$1{\cdot}778 \times 10^{3}$	$3{\cdot}162 \times 10^{6}$
$3{\cdot}162 \times 10^{-4}$	$1{\cdot}000 \times 10^{-7}$	**70**	$3{\cdot}162 \times 10^{3}$	$1{\cdot}000 \times 10^{7}$
$1{\cdot}778 \times 10^{-4}$	$3{\cdot}162 \times 10^{-8}$	**75**	$5{\cdot}623 \times 10^{3}$	$3{\cdot}162 \times 10^{7}$
$1{\cdot}000 \times 10^{-4}$	$1{\cdot}000 \times 10^{-8}$	**80**	$1{\cdot}000 \times 10^{4}$	$1{\cdot}000 \times 10^{8}$
$5{\cdot}623 \times 10^{-5}$	$3{\cdot}162 \times 10^{-9}$	**85**	$1{\cdot}778 \times 10^{4}$	$3{\cdot}162 \times 10^{8}$
$3{\cdot}162 \times 10^{-5}$	$1{\cdot}000 \times 10^{-9}$	**90**	$3{\cdot}162 \times 10^{4}$	$1{\cdot}000 \times 10^{9}$
$1{\cdot}000 \times 10^{-5}$	$1{\cdot}000 \times 10^{-10}$	**100**	$1{\cdot}000 \times 10^{5}$	$1{\cdot}000 \times 10^{10}$
$3{\cdot}162 \times 10^{-6}$	$1{\cdot}000 \times 10^{-11}$	**110**	$3{\cdot}162 \times 10^{5}$	$1{\cdot}000 \times 10^{11}$
$1{\cdot}000 \times 10^{-6}$	$1{\cdot}000 \times 10^{-12}$	**120**	$1{\cdot}000 \times 10^{6}$	$1{\cdot}000 \times 10^{12}$
$3{\cdot}162 \times 10^{-7}$	$1{\cdot}000 \times 10^{-13}$	**130**	$3{\cdot}162 \times 10^{6}$	$1{\cdot}000 \times 10^{13}$
$1{\cdot}000 \times 10^{-7}$	$1{\cdot}000 \times 10^{-14}$	**140**	$1{\cdot}000 \times 10^{7}$	$1{\cdot}000 \times 10^{14}$

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